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ECLAMPSIA

ITS PREVENTION AND CONTROL BY MEANS OF FLUID LIMITATION AND DEHYDRATION[1]

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ECLAMPSIA has required some rational basis of treatment directed toward certain fundamental physiological disturbances that occur within the brain. As the cerebral symptoms, which culminate in convulsive seizures, constitute the serious and terminal manifestations of this condition, an analysis of the problem from this angle is important.

Exploration during the terminal stage of eclampsia has shown the brain to be gray-white (anæmic), œdematous, and often associated with excessive amounts of extra arachnoid and subarachnoid cerebrospinal fluid. Histological study indicates widespread cerebral œdema, enlarged perivascular fluid spaces, and frequently punctate hæmorrhages as well as occasional focal or extensive recent subarachnoid hæmorrhage.

Pathologically, the eclamptic brain differs little from "wet brains" or cerebral œdema found in other well recognized hydration states such as acute alcoholic wet brain, status lymphaticus, acute toxic hydration states in children, and status epilepticus.

The terminal cerebral symptoms are similar throughout this entire group. Headache, vomiting, irritability, and mental torpor occur early followed by stupor, convulsions, and respiratory failure. These symptoms have constantly arisen in neurosurgical problems dealing with brain tumors, increased intracranial pressure, and cerebral œdema. Physiological research during the past 12 years has established many of the factors concerned with intracranial pressure, cerebrospinal fluid circulation and disturbances, which give rise to cerebral œdema. The method of treatment devised to control these symptoms is applicable to eclampsia.

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PHYSIOLOGICAL CONSIDERATIONS

Weed and his co-workers (1919–1929) demonstrated that hypotonic fluid (water) given by vein or bowel increased intracranial pressure, whereas hypertonic solutions (magnesium sulphate, sodium sulphate, etc.) decreased intracranial pressure. Rowntree (1922–1926) demonstrated that when quantities of tap water (one-tenth of body weight) were introduced by stomach tube into the dog, irritability, salivation, twitchings, convulsions, stupor, and respiratory failure usually occurred within 4 to 5 hours. If pituitrin was given early in the administration of the fluid so as to produce a vasospastic effect and thus cut down renal elimination, the cerebral symptoms and con-

vulsions were precipitated much more rapidly. Fremont-Smith (1927–1929) has offered further confirmation of this factor. Kubie (1926–1928) showed that dogs given the Rowntree method of "water intoxication," if subjected to continuous spinal drainage during the water introduction period, did not develop convulsions or signs of cerebral irritation. Elsberg and Pike (1926–1929) demonstrated that hydrated animals were more susceptible to convulsant drugs than the normal and that dehydrated animals required twice the dose of absinthe to produce convulsive seizures required by the normal animals. McQuarrie (1927–1929) has reported the clinical results in human beings where convulsions have been easily induced in the epileptic by the addition of pituitrin in the presence of free indulgence of fluids. One of us (Fay, 1923–1930) has shown that excessive fluid intake *predisposes* the epileptic to an attack and that acute major seizures have been controlled by methods of dehydration.

The recent suggestion of Foster Kennedy (1923–1924) to consider all conditions manifesting convulsive seizures under a single group, "The Convulsive State," has found much support from many neurologists. The search for a common factor responsible for the predisposition of the patient to a convulsive seizure has narrowed down to the fundamental relationships between fluid (œdema), oxygen, and the acid base variations with their local effect on capillary circulation and permeability. Lennox and Cobb (1928) summarize the following physiological changes in the brain which may tend to precipitate convulsive seizures: (1) poor oxygen supply; (2) alkalosis (induced by alkali ingestion or by hyperpnœa), ("blowing off" carbon dioxide); (3) œdema; (4) increased permeability of tissues; (5) increased intracranial pressure.

It will be seen that these factors all effect fluid mobility and hence enhance an already existing hydration state.

The considerations named indicate that the eclamptic in many respects simulates the prepared physiological animal in that a hydration state usually exists, a vasospastic hypertension is present and there is frequently a renal decompensation associated with fluid retention. In the past, continued fluid administration to the patient without proper consideration as to its possible elimination has been a constant method of practice in spite of the evident water imbalance. Where skin and bowels are adequate to meet the renal deficiency in fluid elimination, a proper balance of fluids is maintained. However, with the advent of some sudden curtailment in skin function (cold weather—hyperthermia with dry skin) in the presence of renal insufficiency, there may be a precipitation of fluid retention. It is interesting in this connection, to note the high incidence of eclampsia in the seasonal change of the early winter months, as well as the frequency of peripheral œdema and the occurrence of hydramnios in the light of these recent physiological considerations regarding water metabolism.

Important work regarding the influence of carbohydrates and especially fixed base sodium on the water retention of the body has been done by Gamble, Ross and Tisdall (1923) and the direct relationship between water storage and the convulsive seizure by Gamble (1929) clearly indicates the need for consideration of the problem from this standpoint. Diet becomes of equal importance in the management of water balance in conditions where hydration states tend to occur. Foods high in water content and concentrated carbohydrates (ice cream, candy, syrups, sweet desserts, etc.) must be avoided to prevent water storage during re-establishment of body water balance.

HISTORICAL CORRELATION

George B. Payne (1848) reported autopsy findings in a case of intrapartum convulsions from which he concluded that "it is extremely probable that the serous and cellular structures within the encephalon were also subject to this passive dropsy; the effusion, however, was not sufficient in amount to give indications of cerebral pressure, until congestion of the cerebral vessels under the parturient efforts, increased the latent pressure so much as to excite the convulsive action. The vessels thus in a state of previous plethora, would readily pour out more of the watery part of the blood, causing greater pressure upon the brain."

Francis H. Ramsbotham (1861) stated that "the most usual proximate cause of puerperal convulsions, is probably pressure on the brain, and is produced sometimes by serous exudation into the ventricles or between the membranes. Believing that the cause most commonly consists in the pressure to which the cerebral mass is thus subjected, the treatment must be adopted that would be resorted to under ordinary apoplexy, viz.: the abstraction of blood, and acting briskly on the intestinal canal."

Hugh L. Hodge (1864) writes: "Puerperal convulsions arise, it has been almost universally believed, from congestion of the blood vessels of the brain, or from actual effusions of serum or blood into its substance or cavities. . . . Modern theorists consider such convulsions to be the result of a toxicæmia, or blood poisoning, but the evidence of any poison or malcondition of the blood, is exceedingly meagre. Toxicæmia appears to have been inferred, rather than positively proven. . . . I have long been of the opinion that the increased excitability of the nervous system generated by pregnancy (which is very analogous to that of the young child—easily excited to convulsions from comparatively trivial causes), together with the natural tendency to plethora and increased vascular excitement seen in all cases of pregnancy, constitute the predisposing causes of puerperal eclampsia. . . . such nervous irritation and vascular congestion not only interfere with the functions of the brain, but these changes are often followed by watery or bloody effusion, augmenting to a still greater degree, such functional disturbances. . . . Should the brain, therefore, be the seat of irritation from a moral cause, followed by congestion, and especially sanguineous effusions, the cerebral functions will be correspondingly deranged as manifested by headache, delirium, convulsions, coma, and it may be death."

Angus MacDonald (1878) states: "The most striking alterations, and those I think which we are entitled to regard as the most essential to eclampsia, are (1) the extreme anæmia of the collective cerebrospinal centers; and (2) the coincident equally extreme meningeal engorgement. . . . These two conditions seem to me to be complementary—the one the result of the other. . . . For explanation of how they arise, we may turn to the theory of Traube as applied to puerperal convulsions by Rosenstein (*Die Pathologie und Therapie der Nierenkrankheiten*, 1870). 'According to this view, eclamptic convulsions are not occasioned by poisons in the blood, but result from cerebral anæmia, which in turn is a consequence of cerebral œdema. The blood of pregnant women is normally increased in quantity, but is of defective quality,—being, in fact, too watery. It is, moreover, propelled under increased tension inasmuch as the left ventricle of the heart hypertrophies during pregnancy—especially in the later months. During labor, this exalted tension is very greatly increased. This results in cerebral hyperæmia, which leads to effusion of serum from the watery blood into the cerebral tissues. The pressure of this œdema reacts so as to prevent the dilatation of the cerebral vessels traversing the œdematous areas, and anæmia is the result.' If this occurs in the cerebrum, we have coma, if in the motor centers, convulsions result."

W. Zangemeister (1911) expressed the belief: (1) that cerebral œdema, and (2) that reflex painful irritations, particularly those due to uterine contractions, are intimately associated in the cause of eclampsia. Upon trephining the brain in 3 cases of eclampsia during the acute convulsive state, marked cerebral œdema was noted, associated with increased amounts of subarachnoid fluid. In 2 cases marked benefit was shown from this open drainage of the subarachnoid space and the results compare favorably with the work of Alexander (1911) who devised a method of trephine with "fenestration" for treatment of chronic convulsive seizures.

Eight years ago one of us (Fay) observed similar findings in the terminal state of eclamptic convulsions in 2 cases, with marked improvement in the convulsive seizures following drainage. The increase in volume of subarachnoid fluid was striking. The cortex was gray-white, soggy, and œdematous. No other gross lesion appeared in the motor area. Pathological studies in one case disclosed widespread cerebral œdema. The operative and pathological findings were similar to those

noted in cases of status epilepticus, essential hypertension associated with convulsions, acute uræmia of nephritic origin, and alcoholic and post-traumatic wet brains complicated by Jacksonian convulsive seizures. The cerebral œdema was common to all and the terminal symptoms similar to those of eclampsia. These observations formed the early basis for the present dehydration treatment and water balance routine employed in the acute and chronic convulsive state and reported elsewhere (Fay 1927–1930).

Hirst (1918, p. 591) places great importance upon renal elimination: "as the kidney symptoms increase in severity, eclampsia becomes more imminent; with improvement in the kidney symptoms, the danger of eclampsia decreases; . . . . From the clinical point of view, it is a mistake to minimize the importance of the kidneys . . . . and a treatment to avoid strain on the kidneys and to permit free urinary excretion is the only effective treatment of eclampsia except the termination of pregnancy. . . . The kidneys in pregnancy may become insufficient excretors, by reason of the kidney of pregnancy, of nephritis, of increased intra-abdominal pressure, or of direct pressure on the ureters. It is important in practice to appreciate that *the kidneys may be diseased and yet functionally sufficient, or that they may be healthy anatomically, but functionally insufficient.*"

DeLee (1928, p. 386) discusses Zangemeister's defense of the theory "that increased intra-cranial pressure causes the convulsions and all the symptoms, there being an œdema of the brain similar to that occurring in other portions of the body—the legs, the eye-lids, etc.," adding, — "a very plausible theory and one that if proved, would give us rational methods of treatment."

Stroganoff (1930) stresses the importance of vascular spasm in the origin of eclampsia and there is no doubt that a vasospastic condition obtains (*vide infra*) as the basis for the hypertension and this, associated with cerebral œdema, is sufficient to produce a profound brain anæmia, whereas generalized cerebral vascular spasm alone could not account for the clinical findings and would be frequently associated with permanent paralysis as evidenced in conditions of true vascular spasm encountered in neurological practice. That the state of the vessels determines their permeability to fluids as a factor in this problem has much physiological support. That Stroganoff emphasizes the importance of fluid elimination through the skin is evidenced by his statement that "perspiration which is doubtless connected with weakening or cessation of the vascular spasm, is one of the valuable indications of the favorable course of the disease—fits, as a rule, are then interrupted."

His treatment is directed entirely toward prevention of the convulsive seizure by massive sedative administration and in this respect, he is far in advance of the profession and has reached the point of view held by profound students of convulsive seizures in epilepsy such as Hughlings-Jackson, Gowers, and S. A. Kinnier-Wilson. Stroganoff's efforts to protect the motor centers from centrifugal sensory impulses is characterized by isolation of the patient, curtailment of all possible noises, complete removal of all painful stimuli such as hypodermic medication, catheterization and enemata, advocating chloroform anæsthesia during their procedures. The liberal use of morphine and chloral hydrate further reduces the central reception of peripheral sensory stimuli. He has thus recognized that the convulsive seizure requires the introduction of a sensory stimulus and that the convulsion *per se* belongs in the category of mass reflex activity and is inherently a neurological mechanism. The most advanced theories today dealing with the problem of the convulsive state stress the point of view that the motor mechanism must be prepared physiologically so that an *appropriate* sensory stimulus permits its sudden and intermittent discharge.

Physiologically, the work of Rowntree, Kubie, Elsberg, and Pike, and others, indicates that hydration states most frequently produce the predisposing factor necessary for a true generalized convulsion.

Stroganoff further states: "The entire skill in treating eclampsia consists in succeeding in creating such conditions as will interrupt the fits and at the same time lessen the vascular spasm. The symptoms indicating a sufficient effect are as follows: quiet sleep, restful posi-

tion in bed, which is occasionally interrupted by the onset of labor pains in intrapartum eclampsia, the disappearance of convulsive contractions of the hands, an increase in the amount of urine passed, perspiration, a decrease in the tension of the pulse, and then the regaining of consciousness." Though he does not indicate the factors concerned in diet and fluid administration, it is evident that the narcosis induced, temporarily curtails this factor and only in the giving of an enema is there indication that the treatment permits unnecessary administration of fluids. His pronouncement that the convulsive seizure itself is associated with the most evident danger encountered in eclampsia comes undoubtedly from his recognition of the well known fact that intracranial pressure is greatly increased during the active phase of a convulsive seizure. This, if added to an already œdematous structure within the closed confines of the skull, may bring about the terminal compression and failure of the vasomotor and respiratory centers.

Because morphine is a depressant to the respiratory center, its use in large doses has been considered dangerous by us if intracranial pressure already exists. For this reason, it has not been employed except when absolutely necessary in our series. Its use has not been required when adequate dehydration has relieved the pre-disposition to convulsive seizures by removal of the excessive cerebral œdema.

The work of Kocher (1893–1898) and Ito (1899) as well as the recent physiological school of research in water metabolism has offered adequate support to Zangemeister's belief, and in our opinion, confirmation has arisen not only from the observations on epilepsy and the acute convulsive state, but the treatment to be described has been directed toward the prolonged relief of intracranial pressure with results which DeLee has already anticipated.

Plass (1923) has repeatedly called attention to the fact that œdema of the brain is an almost invariable finding at autopsies on eclamptic patients. Moreover, œdema of the lungs was one of the most dreaded complications. It would seem then that water retention is, as Zangemeister insists, an essential factor in the production of the symptom complex.

Williams (1930, p. 668) lays stress upon the Zangemeister, Traube-Rosenstein theory of cerebral œdema: "The headache and eye signs from swelling of the brain and retina," or, as he expressed it in 1921, "the long sought for cause is undoubtedly water." Williams, however, raises two objections: first, "that it does not explain the production of the characteristic hepatic lesions," and second, "that it takes no account of the cases of eclampsia without œdema which, in my experience, offer the most serious prognosis."

Concerning the hepatic lesions, there is no direct evidence that they of themselves can produce the cerebral manifestations noted in eclampsia which are common to other convulsive states not associated with hepatic disease. As a contributory factor, they may play a part, but as the pathology is neither pathognomonic or persistently constant in eclampsia as recently shown by the careful analysis of 38 autopsies reported by Acosta-Sison (1931), who states that "it seems to point out that the liver lesions and other acute organic lesions and the convulsions in eclampsia are primarily the result of a common origin."

There are many metabolic and mechanical factors associated with pregnancy and the uterine bulk to produce local changes in intrathoracic and portal venous pressure coincident with the convulsive seizures which might account for some of the acute hepatic pathology.

That cerebral œdema is frequently present in many neurological and neurosurgical conditions without evidence of peripheral œdema permits Williams's second objection to be open to further investigation as undoubtedly the work of Swift (1928–1929) and one of us (Fay) has demonstrated that cerebral venous anomalies and intrinsic disturbances of cortical circulation occur in approximately 16 per cent of "idiopathic" epileptics and some early hydrocephalics.

The predisposition toward cerebral œdema when conditions of renal insufficiency and hydration supervene in this group might be expected readily to predispose certain pregnant patients to acute cerebral disturbances resulting from venous and cerebrospinal fluid

circulatory decompensation. These cases would offer a serious prognosis because of the intrinsic cerebral circulatory defect, and the anomalies are sufficiently frequent in the "idiopathic" epileptic group to infer their presence to varying degrees throughout such a common state as pregnancy.

CLASSIFICATION AND TREATMENT

The application of a routine method of treatment directed toward control of the cerebral œdema in the acute eclamptic as well as a definite program of management of the fluid balance in the pre-eclamptic was undertaken, therefore, in our cases, with the object of controlling or preventing the cerebral manifestations, thus permitting the use of other clinical means to be directed toward the renal insufficiency and hypertension.

We have chosen to divide our patients into three groups, citing illustrative cases in each group: (1) the moderately pre-eclamptic; (2) the dangerously threatening pre-eclamptic (a) without chronic nephritis, and (b) with complicating chronic nephritis; (3) the actively eclamptic, or convulsant group.

An outline of the treatment recommended for each group based on the physiological considerations noted above, with the results obtained in typical cases, follows.

1. The Moderately Pre-Eclamptic

Patients with definite signs of hypertension, albuminuria, œdema of the extremities, headache, and beginning visual disturbances have been placed in this group. In several of the patients all of these symptoms were present, while in others there was only a sufficient number of them to arouse apprehension regarding the further progress of the pregnancy.

The steps used in treatment follow:

a. The total output of urine for 24 hours is measured and charted. (Patient is placed on a minimum of intake or denied fluids entirely during this 24 hour period.)

b. Total fluid intake (water, tea, milk, coffee, soup, fruit juices, and other beverages) is regulated so as not to exceed the amount of urine output for the first 24 hours.

c. As far as practical, the level of fluid intake is maintained so as to equal and balance with the previous day's output. An accurate chart record is made of the intake and output of fluid and the patient is weighed daily.

d. Moderate dehydration is accomplished with small daily doses of magnesium sulphate (saturated solution). The liquid volume of this dose is not to be included in the daily intake chart as this fluid is lost through other than renal elimination.

e. A diet of solid foods of wide varieties including proteids is given. The patient is fed *well* but *moderately*, a salt-low diet, soft and liquid nourishment high in water content being avoided, as are also sweets and desserts.

f. Food and drink are given at 3 hour intervals throughout the day, no eating or drinking being permitted between these small meals.

This routine procedure places the level of intake of fluids at the point of maximum renal efficiency, and permits sufficient fluids in the food content to care for skin, breath, and bowel elimination. The mild purgation assists in withdrawing tissue bound fluid from the interstitial spaces, not only in the extremities, but within the cerebral structures as well.

CASE REPORTS

CASE 1. Mrs. S. H., white, aged 22 years, i-para, was admitted to Temple University Hospital March 9, 1931, and discharged March 15, 1931. She complained of headache and swelling of the face and feet. Nausea and vomiting had been present during first 3 months of pregnancy, but there had been no other symptoms until a few days before she entered the hospital. Examination disclosed swelling of face and ankles. Blood pressure was 184–108. Urinalysis showed specific gravity, 1.021; reaction, neutral; cloud of albumin, otherwise negative. Blood urea was 11.5; uric acid, 5.0; creatinin, 1.28; sugar, 90.9. Wassermann reaction was negative. Patient gave a history of excessive fluid ingestion and hearty eating. The uterus was midway between the umbilicus and ensiform.

No fluids were permitted during the first 24 hours; the output was 36 ounces. The fluid intake was restricted to 20 ounces. On the second day, the output was 25 ounces. The blood pressure fell to 160–94. Patient was much improved. On the third day, the intake was 20 ounces and output 47 ounces. The blood pressure fell to 152–84. The œdema of face and ankles disappeared. Patient balanced on an intake of 25 ounces. She was discharged on sixth day symptom free with blood pressure of 130–84, and was referred back to her family physician.

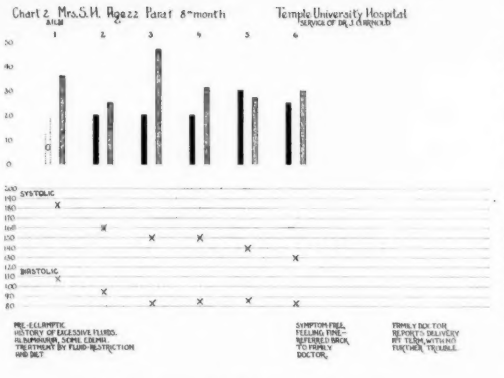

Fig. 1. Case 1. Black, intake; gray, output.

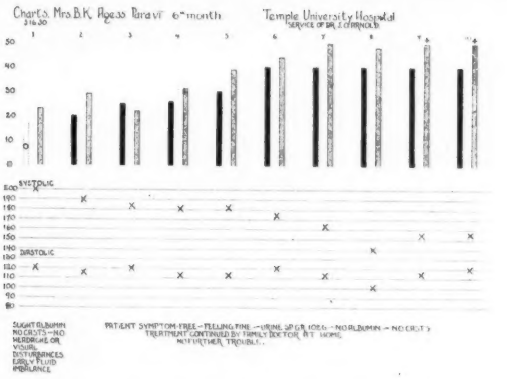

Fig. 2. Case 2. Black, intake; gray, output.

Patient came to full term delivery without complications on March 24, 1931. The blood pressure was 164–100, the urine showed cloud of albumin, no casts. Subsequent progress was uneventful.

Note in Figure 1 the excessive output of urine during the 4 days with subsequent clearing of the œdema; the prompt fall in blood pressure following dehydration; and the satisfactory progress on 25 ounces of total fluid intake maintained up to the time of delivery.

CASE 2. Mrs. B. K., white, aged 35 years, vipara, was admitted to Temple University Hospital March 16, 1930, and discharged March 27, 1930. Patient referred because of hypertension (200–120); no other symptoms. Patient had had three miscarriages, two normal deliveries, and was now 6 months pregnant. Hypertension was discovered during the routine examination. No other symptoms were noted. Physical examination was negative. Urinalysis on admission showed: specific gravity, 1.020; reaction, alkaline; cloud of albumin, no casts. Blood analysis showed non-protein nitrogen, 75.0; uric acid, 3.3; creatinin, 1.31; sugar 76.9. The Wassermann reaction was negative.

Progress was uneventful with fall of blood pressure to 140–100 on the eighth day. The fluid intake was begun at 20 ounces level and gradually increased to 40 ounces per 24 hours. Patient was discharged on tenth day with blood pressure 156–120; specific gravity of the urine 1.026, with faint trace of albumin. Her condition was good. She was delivered at full term without complications.

It should be noted that patient received no fluids during the first 24 hours. Because of the low output (24 ounces), the intake was placed at 20 ounce level (Fig. 2) and was gradually increased as the output rose, the intake being maintained always slightly below the output. The final level of 40 ounces' intake is considered the maximum to meet all body needs, as shown by our experience. It should also be noted that the output was in excess of 50 ounces on the ninth and tenth days, thus indicating the release of stored tissue fluids and the effect of dehydration. The progressive and sustained fall in systolic pressure indicates the removal of the element of danger in these cases and has been an almost constant finding throughout the series. The vasospastic factor underlying the hypertension remains, as evidenced by the continued high diastolic figure (156–120) on discharge. Under fluid limitation, it is interesting to note too the improvement in albuminuria.

CASE 3. Mrs. M. J., white, aged 25 years, i-para, was admitted to Temple University Hospital February 19, 1931, and discharged March 11, 1931. Her chief complaints were headache, blurred vision, dizziness, swelling of extremities, and dyspnœa. She had been well until 4 months prior to admission when, following an automobile accident, she noted pains simulating labor pains. Three months before admission she complained of blurred vision, diplopia, dizziness, and dyspnœa at night. Recently she had noticed swelling of the legs, headache, and flushing of the face. There had been an increase in the symptoms of visual disturbance, œdema of the extremities, and dizziness. She had had no previous pregnancies or miscarriages. She had had no vomiting spells but had occasional frequency and nocturia. Her diet and fluid intake had been unrestricted. Physical examination disclosed a well developed female; the uterus at ensiform; the extremities œdematous; the heart muscle tone good, with accentuated aortic second sound; the blood pressure 158–110; the chest negative. Urinalysis: specific gravity 1.007; reaction, acid; heavy cloud albumin; hyaline casts.

With the establishment of a balance of fluid intake and output (Fig. 3), the headache was relieved, and vision cleared. She had normal labor and delivery February 26, 1931. Recovery was uneventful.

The rapid clearing in the symptoms of œdema, headache, visual disturbance, and dyspnœa was striking. The balance of intake and output indicates the mild saline purgation was adequate in removal of the excess tissue fluids so long as fluids were restricted to the level of output. The blood pressure

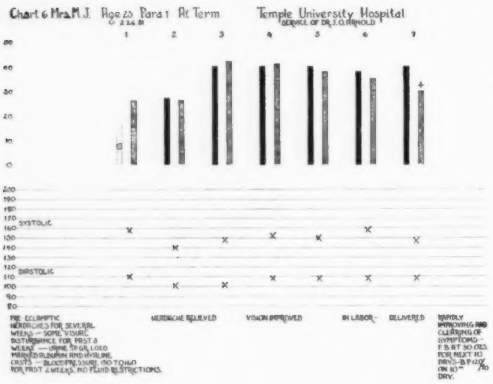

Fig. 3. Case 3. Black, intake; gray, output.

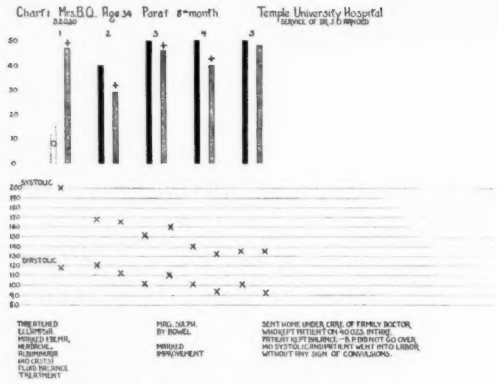

Fig. 4. Case 4. Black, intake; gray, output.

on discharge was 120–95. The urine showed no casts and a trace of albumin.

In the moderately pre-eclamptic group a prompt and beneficial effect was noted when the patients were placed on restricted fluid intake not in excess of the predetermined output. Headache, visual disturbances, œdema, and the hypertension disappeared. The vasospastic underlying condition remains in some cases as evidenced by the persistence in high diastolic pressure. The urinary picture improves definitely under proper fluid balance and mild purgation. A normal full term delivery occurred in all patients of this group.

2. The Dangerously Threatening Pre-Eclamptic

In this group are those (a) without chronic nephritis, and (b) with complicating chronic nephritis.

This subdivided group includes those patients having a marked or alarming degree of hypertension, albumin and casts, and external œdema, with aggravated headache, vomiting, visual disturbances, or other cerebral symptoms. It is difficult or often impossible to classify pre-eclampsia patients accurately on the basis of the presence or absence of pre-existing nephritis; yet, the history, clinical findings, and laboratory and eye ground studies, usually make such a division practicable.

The general principles of treatment are the same for group A and B, but group B requires earlier application of the treatment with more careful and persistent control of fluids and diet as the response is slower and the danger of renal suppression more imminent.

a. All fluids (and usually all food) are withheld until the 24 hours urine output is known; then an intake at or slightly below the daily output is maintained.

b. The process of dehydration is begun at once by giving intravenously 50 cubic centimeters of 50 per cent glucose, and this dose is repeated in 4 to 6 hours, if necessary.

c. A saturated solution of magnesium sulphate, one or more doses, is given by mouth until effective in watery stools. This is repeated daily, or as indicated.

d. If no marked improvement is seen in 15 to 30 hours, one or more spinal drainages is done, at 4 to 6 hour intervals, or rarely, when spinal puncture is impractical, venesection is done, the blood pressure cuff being used as a tourniquet in order to check the effect on pulse pressure.

e. A strict balance of fluid and "dry" solid diet is maintained.

This more intensive method of dehydration permits adjusting treatment to the degree of urgency apparent in the case. Many patients in this group yield promptly and satisfactorily to one or more of the measures without spinal drainage, if fluid intake is carefully curtailed, but spinal drainage should not be long deferred if headache and other cerebral symptoms have not decidedly abated within a few hours.

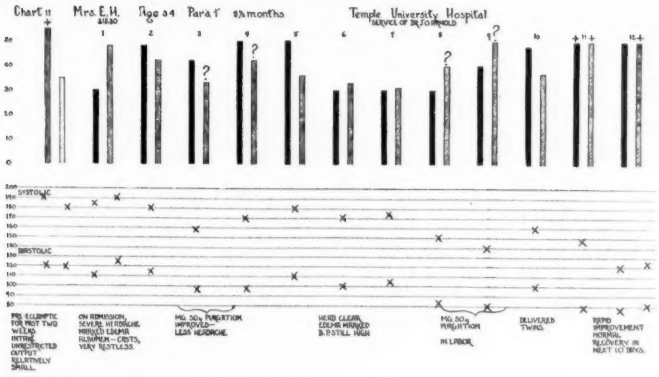
Chart 11
Mrs. E. H.
Age 34
Para 1
9 months
Temple University Hospital
SYSTOLIC
DIASTOLIC
PRE ECLAMPTIC FOR PAST TWO WEEKS INTAKE UNRESTRICTED OUTPUT RELATIVELY SMALL
ON REMISSION, SEVERE HEADACHE, MARKED EDEMA. ALBUMEN – CASTS, VERY RESTLESS.
MG. SO4 PURGATION IMPROVED – LESS HEADACHE
HEAD CLEAR, EDEMA MARKED B. P. STILL HIGH
MG. SO4 PURGATION IN LABOR.
DELIVERED TWINS.
RAPID IMPROVEMENT NORMAL RECOVERY IN NEXT 10 DAYS.

Fig. 5. Case 5. Black, intake; gray, output; striping, measured fluids immediately before admission.

Group A, without Chronic Nephritis

Case 4. Mrs. B. Q., white, aged 34 years, i-para, was admitted to Temple University Hospital March 20, 1930, and discharged March 25, 1930. She complained of severe headache, dizziness, slight visual disturbances, and marked œdema of face, and lower extremities. Patient had good general health, having had no illnesses since childhood. She had been slightly nauseated in first 3 months of pregnancy, but had had no other symptoms or disturbances until 2 weeks before admission. Headache was the first symptom. Hypertension was noted a week later. The œdema was noted in last 2 weeks. Headaches had increased. The history indicated an effort to increase the output of urine, by forcing fluid intake and giving cathartics. Both patient and her physician were much alarmed at the rapidly increasing severity of symptoms. Patient was a well developed woman, with heart and lungs normal. The fundus of the uterus was two fingers below the ensiform. The fetal heart was heard in the lower right quadrant. There was marked œdema of the ankles and legs. Blood pressure was 200–120. Urinalysis showed specific gravity, 1.014; reaction, acid; trace of albumin; no casts. Blood analysis showed non-protein nitrogen, 27.5; uric acid, 3.6; creatinin, 1.27; sugar, 76.3.

All fluids were withheld for 24 hours (Fig. 4). The fluid balance was maintained at about 50 ounces, with daily doses of 1 ounce of saturated solution of magnesium sulphate by mouth, followed by rapid improvement. Patient was returned to the care of her family physician after 5 days. The headache was entirely relieved. Blood pressure was 134–90. With a continuation of fluid balance treatment at home, there was no return of her pre-eclamptic symptoms. Normal delivery at term.

This patient developed her pre-eclampsia rather suddenly, and her danger symptoms advanced rapidly. With fixation of the fluid intake level and general routine in diet following the necessary dehydration measures, a normal state ensued followed by an uncomplicated delivery.

Case 5. Mrs. E. H., white, aged 34 years, i-para, was admitted to Temple University Hospital March 15, 1930, and discharged March 29, 1930. She complained of headache, dizziness, blurred vision, œdema of legs, restlessness, and insomnia. She had had influenza in 1918, but no other serious illness and no operations. She had had some nausea and vomiting in the second month of pregnancy. Until about 3 weeks before admission, she had had no other disturbances during pregnancy. Swelling of the legs became alarming about 3 weeks ago. Visual disturbances occurred about 2 weeks before admission. A noticeable diminution in the output of urine had occurred recently, and there had been an attempt to overcome this by increasing the fluid intake. Headache began about 10 days ago with daily increasing severity. She did not vomit. Eating had been irregular and erratic. She suffered marked fear and restlessness. Patient was fairly well nourished, well developed. The teeth were in poor condition, many were missing. The heart showed fair muscle tone, no murmurs. The lungs were normal. The abdomen had the size and appearance of an unusually large, full term pregnancy. The fetal heart was heard in the right lower quadrant. There was marked œdema of the legs and feet. Blood pressure was 176–100. Urinalysis showed specific gravity, 1.020; reaction, acid; heavy cloud of albumin, hyaline and granular casts. Blood analysis showed sugar, 80; non-protein nitrogen, 35.7; uric acid, 4.6; creatinin, 1.26. The Wassermann reaction negative.

The urine output for the first 24 hours was 34 ounces. Patient was given an allowance of 30 ounces in the second 24 hours. There was marked improvement following the restriction of fluid intake and repeated magnesium sulphate purgings. Marked improvement seemed to warrant continuation of the pregnancy. Normal convalescence and spontaneous full term delivery ensued.

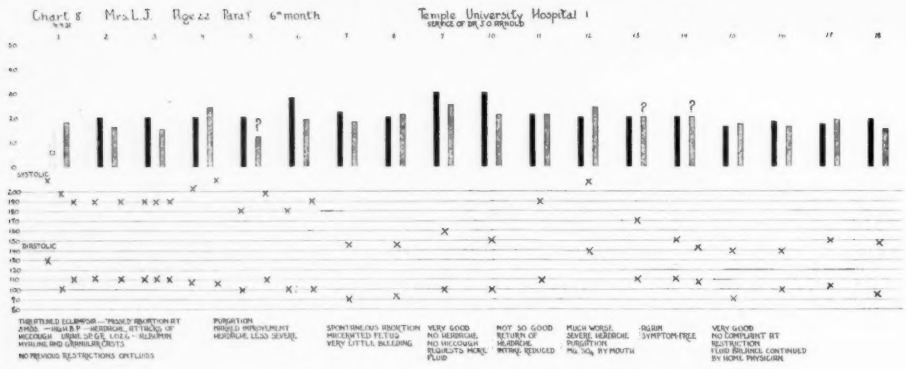

Fig. 6. Case 6. Black, intake; gray, output.

In the 24 hours immediately preceding admission to the hospital, this patient upon instruction had measured her fluid intake which was more than 76 ounces, as indicated by the first column in Figure 5. The urine output had not been previously measured, but the history indicated that for some days or weeks, her intake had greatly exceeded her output.

The rapid and continued improvement following the correction of her fluid imbalance indicates the serious importance of this factor alone in the management of such a case.

Case 6. Mrs. L. J., white, aged 22 years, i-para, was admitted to Temple University Hospital April 4, 1931, and discharged April 22, 1931. She complained of constant severe headache, some blurring of vision, frequent attacks of hiccough, lasting half hour to an hour at a time; and absence of signs of fetal life. Patient had had pneumonia when 3 years old, and scarlet fever at the age of 14 years. She has had no illness since, and there had been no occasion to have blood pressure taken or urinalysis made, until about 1 month before admission to the hospital. The first 4 months of her pregnancy had passed in normal health, and without complaint. One month ago, she was moderately shocked by a fall while walking. Two days later she began to feel badly and went to a physician. She was told that she had high blood pressure. Patient became greatly worried and nervous. Repeated examinations by her physician in the next 3 weeks failed to discover signs of fetal life, but showed increasing hypertension. She had an attack of vomiting 1 week ago. Headache and hiccoughs had been worse during past week. Physical examination revealed the following: patient, well developed; heart sounds, normal; lungs, clear; uterine fundus, half way to umbilicus; no noticeable œdema; no heart sounds or fetal movements discovered. Blood pressure was 220–110. Urinalysis showed specific gravity, 1.012; reaction, acid; heavy cloud of albumin; no casts; no sugar; no red blood cells.

A strict fluid balance maintained at 20 ounces with daily magnesium sulphate purgings brought prompt relief of headache, but hypertension and hiccough persisted. On the sixth day spontaneous abortion of a macerated fetus of about 4 months size occurred. The hiccough ceased. Continued improvement was noted. Patient asked for more fluid. For 2 days the allowance was increased by 10 ounces above the daily output of urine. This increase was followed at once by a rise in blood pressure to 210–140, and a return of headache. The fluid balance was therefore re-established, and the patient became symptom-free and continued to improve until her discharge.

A case of missed abortion, probably from accidental cause, at the end of the fourth month, and persisting a month, developed dangerously threatening pre-eclamptic symptoms, but improved rapidly on dehydration without the aid of drug therapy, and in the presence of an unusually low fluid balance. When the fluid intake was increased even 10 ounces above the daily output of urine, there was a prompt return of the danger symptoms within 48 hours, in spite of the fact that the uterus was empty, and the patient was free from any infection or pelvic abnormality. The immediate relief obtained upon returning to the previously determined fluid balance of 20 ounces, clearly indicated the value of fluid restriction. No other means of dehydration were found necessary, except occasional magnesium sulphate purgation.

Group B, with Complicating Chronic Nephritis

Case 7. Mrs. G. M., white, aged 23 years, i-para, was admitted to Temple University Hospital, service of Dr. J. M. Alesbury, March 26, 1930, and discharged April 19, 1930. She complained of headache (frontal and occipital), attacks of vomiting, swelling of feet and legs, restlessness, and insomnia. Patient was 6 months pregnant. She had had no serious illness since childhood. She had had measles at age of 8 years. She had been subject to attacks of headache once or twice a week for several years. Headaches had become worse since pregnancy. She had

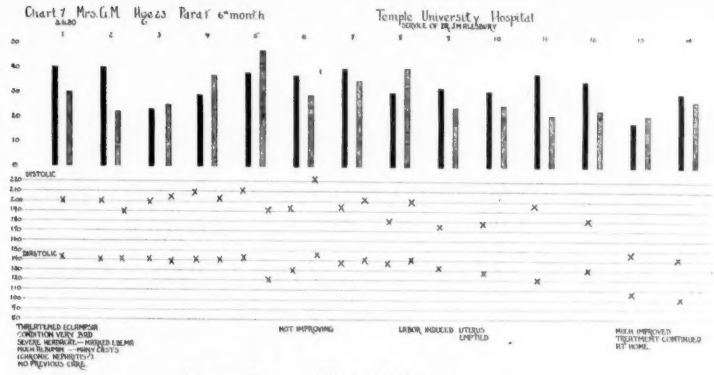

Fig. 7. Case 7. Black, intake; gray, output.

not had medical attention, or any occasion for urinalysis or blood pressure test before pregnancy. She began to notice swelling of ankles and increased severity of headache about 2 months ago. There were no visual disturbances. Nausea and vomiting began 5 months ago and have continued in varying severity since. Patient's general physical condition appeared fairly good. Her teeth were in poor condition and there was marked gingivitis present. The tonsils were enlarged and injected. The thyroid was not enlarged. The heart and lungs appeared normal. The abdomen showed an enlarged uterus with uterine fundus at the level of the umbilicus; otherwise the abdomen was normal. The fetal heart sounds could not be heard. Both legs were markedly swollen, and there was some œdema of the face. Blood pressure was 204–144. Urinalysis showed specific gravity, 1.012; reaction, acid; heavy cloud of albumin; no sugar; many hyaline and fine and coarsely granular casts. The Wassermann test was negative. Blood sugar was 66.6; non-protein nitrogen, 20; uric acid, 2.9; creatinin, 1.49; hæmoglobin, 74; red blood cells, 3,350,000; white blood cells, 10,800; polymorphonuclears, 68; small lymphocytes, 23; large lymphocytes, 6; mononuclears, 0; many crenated red cells.

Some improvement followed the restriction of fluids, but the pulse pressure remained high. On third day, glucose and magnesium sulphate were given intravenously, and headache and other symptoms were much improved following this medication. Hypertension persisted, but patient continued to improve and felt well. At this time, and for several days before, patient felt no fetal movements, and signs of fetal life were not found on examination. On the ninth day in the hospital, labor was induced because of dead fetus, and uterus expelled macerated fetus on tenth day. Continued restriction of intake and mild dehydration by magnesium sulphate purgings gave steady improvement, and patient was discharged after 24 days in hospital to be under care at home. The urine still showed albumin and casts. Final blood pressure was 140–100.

From the fact that this patient had a dead fetus at the sixth month, with no discoverable cause except nephritis, and from the subsequent slow recovery after leaving the hospital, with urinary evidences of nephritis that have persisted, it seems fair to assume that this was a case of early pre-eclampsia, in which chronic nephritis was a predisposing and aggravating factor. Her immediate, urgent, cerebral symptoms responded to the routine treatment. Emptying the uterus of a dead fetus was but a necessary adjunct to the regular treatment. Here, as in 2 other cases in our series (Case 6, group a, and Case 8, group b), there is an apparent refutation of the widely prevalent idea that the death, or removal of the child, lowers blood pressure, and lessens the danger of eclampsism. It is important to note (Fig. 7) that blood pressure showed a definite fall from 210–144 to 190–120 on the fifth day following dehydration, and this was coincident with a rise in the urinary output on that day. On the sixth day there is evidence of water storage with a subsequent rise in blood pressure. The blood pressure had fallen to 174–132 even before the uterus was emptied on the tenth day. There followed a period of water storage with a rise in systolic pressure even after the induced abortion and not until the thirteenth day when fluid intake was sharply cut to 16 total ounces did the blood pressure fall to its final proper relationships.

Case 8. Mrs. M. K., white, aged 37 years, ivpara, was admitted to the Greatheart Maternity Hospital of Temple University, service of Dr. C. S. Barnes, March 29, 1931, and discharged April 18, 1931. She complained of severe headache, dyspnœa, extensive œdema, difficult locomotion, and disturbances of vision. She is now in the ninth month of pregnancy. She has felt bad throughout pregnancy. She has had three previous, full term, uneventful pregnancies, the last 9 years ago. Three children are living and well. Patient has greatly increased in weight since the birth of the last child. She has had no miscarriages and no serious illness in recent years. She has been nauseated and has vomited for past 7

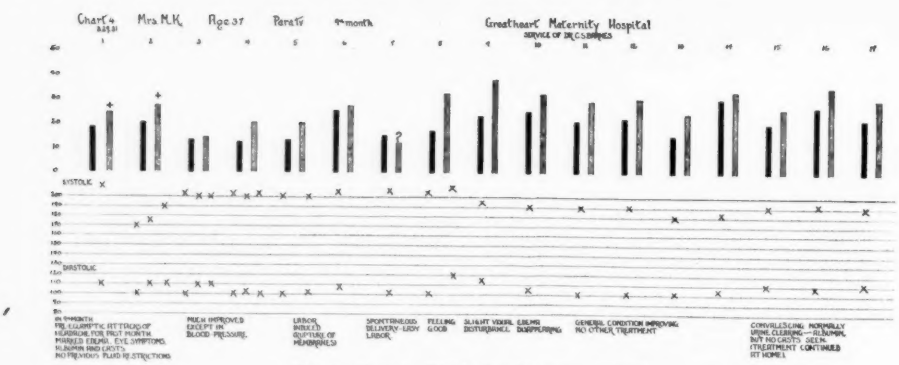

Fig. 8. Case 8. Black, intake; gray, output.

months. She began to have headache, œdema of legs, and ocular symptoms about 2 months ago, with occasional attacks of nausea and vomiting. There is much distress and pressure in the abdomen. Frequent micturition has been noted day and night, but the urine has been scant in quantity. There has been no restriction of fluid intake or diet. She has had severe attacks of coughing at times. Dyspnœa has been marked, and the headache and all symptoms have been aggravated in the past week. For years, she has been a moderate user of alcoholic drinks. Physical examination disclosed a patient of medium height, very stout, excessively fat and œdematous. The uterus was at the ensiform. The heart sounds were good, but rapid (90 per minute). The lungs were normal. The fetal heart was heard in the left lower quadrant. Blood pressure was 210–110. Urinalysis showed the specific gravity to be 1.034; reaction, acid; very heavy cloud of albumin; no sugar; many hyaline and granular casts.

Blood-letting on admission and 24 hours later (30 ounces in all) and restriction of fluid intake (12 to 26 ounces) to amount of output, brought prompt relief from headache, and a pronounced feeling of well-being. The œdema, visual disturbances, and all symptoms greatly improved, but hypertension remained unchanged, with little change in urinary findings. Induction of labor with normal easy delivery was accomplished on the seventh day in the hospital, but there was no improvement in blood pressure or change in the progress of case. However, patient continued to feel well, improved symptomatically, and was discharged on a fluid intake level of 20 to 26 ounces, to continue treatment for her chronic nephritis at home.

The prompt and striking relief of all alarming symptoms, except the hypertension, that followed dehydration methods, was gratifying. As a pre-existing kidney lesion is frequently aggravated when pregnancy is unnecessarily prolonged, it was deemed wise to induce labor early in this case. Characteristic of all cases in this general group of pre-eclampsia superimposed on chronic nephritis, the lowering of blood pressure and the clearing of urinary findings following the delivery, were not immediately seen, and the subsequent reports on this patient, after several months, showed very slow recovery, with evidences of chronic nephritis still present. In this type of case the underlying hypertensive factor is one of cardiorenal disease complicating pregnancy, but it is important to note that such cases yield satisfactorily to prolonged dehydration measures without clinical evidence of renal aggravation and even improve symptomatically in spite of the former beliefs to the contrary.

Case 9. Mrs. E. C., white, aged 30 years, iv-para, was admitted to the Greatheart Maternity Hospital of Temple University, July 9, 1931, and was discharged August 5, 1931. Patient was admitted from out-patient service because of headache, hypertension, scanty urine, and known record of chronic nephritis. Patient was 8 months pregnant. She had had measles, mumps, and whooping cough as a child. She had been married 11 years. She had had appendectomy and right oophorectomy 4 years ago. She had been in good health prior to the first pregnancy 8 years ago. This pregnancy had been terminated by induction of labor at end of the eighth month because of "high blood pressure and kidney disease." The child weighed but 3 pounds, but is living and healthy. Patient did not consult a physician again, until second pregnancy 3 years ago, which ended in spontaneous abortion (said to have been due to kidney disease) in the sixth month. A third pregnancy, 1 year later, ended in miscarriage at the sixth month. Patient applied at the out-patient service in the fourth month of the present pregnancy, complaining of headache, dizziness, transient visual disturbances, and beginning œdema of face and feet. Blood pressure at that time was 168–100. The urine contained albumin and casts. She was treated as an out-patient, except for a period of 10 days in the hospital (June 13 to 23) until present time. Carefully regulated diet and fluid balance methods were instituted. Physical examination reveals a small, frail looking, poorly nourished woman.

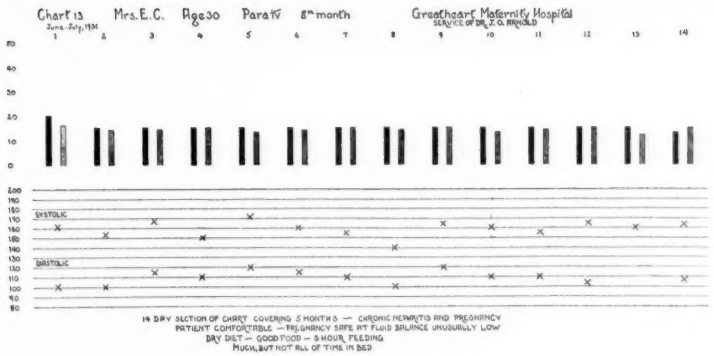
Chart 13 Mrs. E. C. Age 30 Para IV 8th month
Greatheart Maternity Hospital
SERVICE OF DR. J. O. ARNOLD
June-July, 1931
SYSTOLIC
DIASTOLIC
14 DAY SECTION OF CHART COVERING 5 MONTHS — CHRONIC NEPHRITIS AND PREGNANCY
PATIENT COMFORTABLE — PREGNANCY SUPERVENED
DAY DIET — GOOD FOOD — 3 HOUR FEEDING
MUCH, BUT NOT ALL OF TIME IN BED

Fig. 9. Case 9. Black, intake; gray, output.

The heart action was strong, regular, and no murmurs were heard. The lungs were normal. The abdomen was thin-walled, and the uterus was small with fundus midway between umbilicus and ensiform. There was slight pretibial and ankle œdema. Blood pressure was 153–109. Urinalysis revealed the specific gravity to be 1.025; reaction, acid; cloud of albumin; sugar, negative; hyaline and granular casts.

Patient remained cheerful and comfortable when kept quiet in bed, on good food with strict fluid balance treatment. Her appreciation of the obvious relationship between her sense of well-being and the unusually low fluid allowance (an average of 15 ounces) made absolute co-operation possible, and she expressed no desire for further increase. This fluid level was maintained throughout the ensuing 5 months (including June and July) until a normal, spontaneous labor, not far from full term, resulted in a well developed, living child weighing 4¼ pounds, and left the mother in good physical and mental condition.

Under conditions far from being the most favorable, a patient with chronic nephritis which has once endangered, and twice prematurely disrupted her pregnancy, was carried safely through a fourth pregnancy to normal parturition, at or near term, with an apparently healthy child, by careful fluid balance methods. That so low a fluid intake could be maintained over so long a period of time, without great hardship to the patient, and certainly without detriment to her health, is important, and confirmatory of similar experiences with renal complications in other conditions.

Summary. The 6 patients in this group all gave undoubted evidence of threatened eclampsia and responded promptly and beneficially to the effects of systematic restriction of fluid intake and the milder methods of dehydration. Their cerebral symptoms were promptly controlled, and their hypertension and renal functions were more or less favorably influenced. Four of the 6 gave birth to living babies at term. In 1 of Group A the pregnancy was accidentally interrupted at the fourth month, and in 1 of Group B there was intra-uterine death of the child (possibly from the mother's nephritis) at the sixth month. All made normal puerperal recoveries and those with chronic nephritis, have convalesced in a manner to warrant the assumption that their kidney lesions were not greatly aggravated by the pregnancy thus properly controlled and conducted.

In 3 of our cases, in which each former pregnancy was complicated by eclampsia, or pre-eclampsia, requiring the termination of pregnancy because of the association of chronic nephritis, full term normal babies have been delivered, without the advent of eclamptic symptoms, when the patients were placed upon a total intake of fluid not exceeding 20 ounces, throughout the period of pregnancy

3. *The Actively Eclamptic, or Convulsant Group*

We have placed under this division, only those patients in whom such an advanced stage of eclampsism had been reached that convulsive seizures had actually begun. We are not unmindful of eclamptic death without convulsions, but for clinical purposes, the more or less arbitrary grouping into three stages of severity herein outlined, has seemed best to meet the needs for a practical guide in administering treatment.

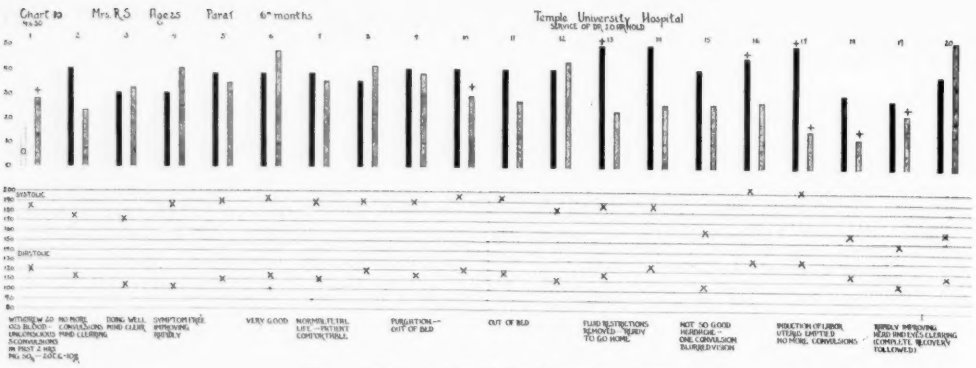

Fig. 10. Case 10. Black, intake; gray, output.

a. Hypodermic injection of sodium luminal, 2 or 3 grains is given immediately and repeated in 2 hours if necessary. Morphine sulphate ¼ to ½ grains is given hypodermatically, only if absolutely necessary and only after the administration of glucose and spinal drainage have been accomplished.

b. At the earliest possible opportunity, 50 cubic centimeters of 50 per cent glucose is given intravenously.

c. The spinal fluid is drained *as completely* as possible (45 to 100 cubic centimeters), preferably with the head raised to an angle of 30 degrees. (When spinal drainage is impracticable, venesection, until systolic pressure drops 30 to 50 points, may be substituted.)

d. The administration of glucose is repeated in 3 to 4 hours, and spinal drainage in 4 to 6 hours, if marked improvement is not seen.

e. Magnesium sulphate is given by mouth or bowel in effectual doses.

f. Absolutely no fluids (except magnesium sulphate solution) are given for at least 24 hours, and the temperature, pulse, respiration, and pulse pressure are recorded every hour.

g. If dehydration has been thorough and effective, the uterus need not be emptied, nor labor induced or hurried, except for reasons other than the attack for which the patient is being treated.

The treatment here outlined provides (1) for a primary sedative directed toward the control of the convulsive seizures; (2) for the early use of hypertonic solutions to attract into the blood stream the tissue bound water; (3) for immediate and rapid cerebral dehydration (by spinal drainage or venesection) which is an extremely important factor, not only in controlling convulsions, but in bringing about early mental restoration, with all its advantages in the further conduct of the case; (4) the use of an active saline purge to withdraw the fluid from the blood stream reclaimed by the intravenous glucose and thus hasten a re-establishment of body water balance.

A repetition of the intravenous glucose and of the spinal drainage, with the maintenance of an accurate fluid balance, and a continuance for some days of milder dehydration by purgation, provides for the further restoration of the patient. The strict avoidance of fluid introduction by vein, skin, or bowel (enema—8 ounces of magnesium sulphate and 1 ounce of glycerine) other than prescribed is important. For complications of severe hæmorrhage blood transfusion should be done and the 50 per cent glucose administration repeated.

CASE REPORTS

CASE 10. Mrs. R. S., white, aged 34 years, i-para, was admitted to the Temple University Hospital April 5, 1930, and discharged April 30, 1930. Patient was brought to hospital in convulsions and unconscious. She had been married 10 months and is now 6 months pregnant. She had had typhoid fever when a child, appendectomy at age of 17 years, and tonsillectomy 2 years ago. There had been much nausea and vomiting during second and third months of pregnancy, but no serious complaints after this until about a week before admission to the hospital. The convulsive seizures were immediately preceded

by violent headache, vomiting, and substernal pain. The convulsions were of an unusually severe type, recurring at 10 to 15 minute intervals, 3 in half hour before admission, and 2 immediately after. There was a history of unrestricted diet and fluid intake. Physical examination revealed a rather stout, well developed female, with markedly swollen face and extremities. The uterus was almost to the umbilicus. The blood pressure was 186–110. Urinalysis revealed specific gravity, 1.022; reaction, acid; heavy cloud of albumin; no sugar; many hyaline and granular casts.

No sedative was given—patient was in deep coma. Venesection was done, 20 ounces being taken. Magnesium sulphate, 20 cubic centimeters of a 10 per cent solution, was given intravenously. There were no convulsions after venesection. Alternating doses of 50 cubic centimeters of 50 per cent glucose, and 20 cubic centimeters of 10 per cent magnesium sulphate were given intravenously at 4 hour intervals for next 24 hours. All other fluids and foods were withheld during this period. Consciousness was regained in 6 hours, and rapid improvement followed. By the fifth day, patient was symptom-free but hypertension persisted, and but little improvement was noted by urinalysis. Fluid restrictions were removed on twelfth and thirteenth days as a test for discharge from the hospital. There was a recurrence of headache, dyspnœa, dimness of vision, and one convulsion on the fifteenth day. The fetal heart was no longer heard. Labor was induced and the uterus was emptied 2 days later of dead fetus. Dehydration by means of blood loss, purging, and withholding of fluids, again brought a clearing of the symptoms and daily improvement. Patient was returned to the care of her home physician on April 3, 1930, with blood pressure 160–110.

Note the prompt control of convulsions, the early return of consciousness, and the rapid and continued improvement that followed imperfect dehydration in one of our early cases. Most important, however, is that 2 weeks later, 48 hours after unrestricted fluid intake, a full recurrence of all former cerebral symptoms occurred, culminating again in convulsive seizures.

It is quite probable, in our opinion, that this recurrent attack had much to do with the death of the fetus and it is probable in the light of subsequent cases that continuation of dehydration would have resulted favorably to the mother and child. Upon the return of the convulsive seizures and the absence of signs of fetal life, dehydration methods were again instituted and the pregnancy terminated. It is important to note (Fig. 10) the satisfactory fluid balance obtained during the first 12 days with symptomatic improvement. The high fluid intake on the thirteenth and fourteenth days was associated with definite signs of renal suppression and prompt return of symptoms due to marked body water storage. Release of stored fluid was evident on twentieth day.

CASE 11. Mrs. K. B., white, aged 32 years, iii-para, was admitted to the Temple University Hospital September 24, 1930, and was discharged October 4, 1930. Patient was admitted by ambulance, after one or more convulsions at home. She was only semi-conscious, wildly restless, irresponsive; apparently blind and deaf. Patient had complained of severe headache, vomiting, and blindness 24 hours before admission. She was then 7 months pregnant. She had had scarlet fever when a child. Three years ago she had had a therapeutic abortion at 6 months, because of a prolonged attack of eclampsia. She had had a spontaneous abortion at 5½ months 1½ years ago, with good recovery. She had been in good health since, until the present pregnancy. Since the second month, she had had frequent attacks of headache, vomiting, and visual disturbances. She gave a history of excessive eating and drinking preceding both this and the former attack of eclampsia. Physical examination revealed a tall, well developed, fairly well nourished woman, with slightly enlarged thyroid, some hypertrophy of the left heart, no murmurs, and chest otherwise negative. The uterus was half way above the umbilicus. The fetal heart could not be heard (it was heard distinctly 4 days later). She had a very slight external œdema. Blood pressure was 174–105. The urine was very scanty on admission; the specific gravity was 1.031; reaction, alkaline; light cloud of albumin; no sugar; very few granular casts; many white blood cells and a few red blood cells. The Wassermann reaction was negative.

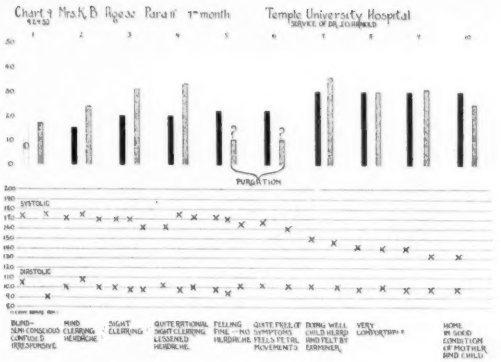

Fig. 11. Case 11. Black, intake; gray, output.

She had no convulsions after she was admitted to the hospital. Venesection bringing the blood pressure down to 150–90, with 50 cubic centimeters of 50 per cent glucose followed in 2 hours with 20 cubic centimeters of 10 per cent magnesium sulphate intravenously, and the withholding of all food and liquids for 24 hours, brought about an early clearing of all symptoms. The output of urine for the first 24 hours was only 17 ounces, so her allowance of fluid intake for the next 24 hours was 15 ounces. By the end of a week, a fluid balance of 30 ounces had been established, and this, with mild magnesium

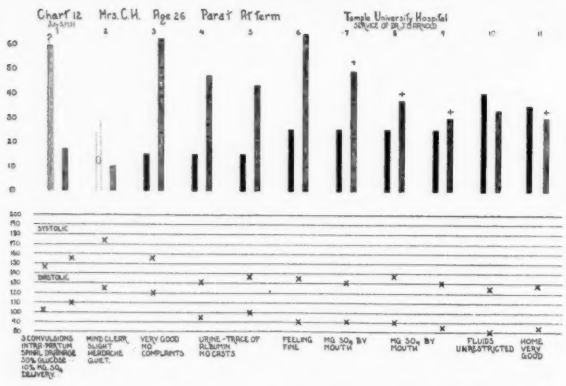
Chart 12 Mrs. C.H. Age 26 Para 1 At term
Temple University Hospital
SYSTOLIC
DIASTOLIC
3 CONVULSIONS INTRA-RECTUM SPINAL DRAINAGE 50% GLUCOSE 10% MG. SO4 DELIVERY
MIND CLEAR, SLIGHT HEADACHE QUIET.
VERY GOOD NO COMPLAINTS
URINE - TRACE OF ALBUMIN NO CASTS
FEELING FINE
MG. SO4 BY MOUTH
MG. SO4 BY MOUTH
FLUIDS UNRESTRICTED
HOME VERY GOOD

Fig. 12. Case 12. Black, intake; gray, output; striping, unlimited intake.

sulphate purgations, enabled us to discharge her in good mental and physical condition after 10 days, treatment, with pregnancy undisturbed.

It is interesting to note the rapidity of recovery following simple dehydration and continued fluid limitation (compare with Case 10) in the light of her former experiences in pregnancy, with the very slow recovery (many convulsions and mental confusion for 10 days) following venesection, sedatives, *and the pushing of fluids* by skin, bowel, and mouth in the former attack. It is doubly interesting to us, for one of us directed her treatment in each attack. A further vitally important consideration is the fact that the child's life was not sacrificed by our present methods, as it was by the methods of 3 years ago.

As this patient was under the care of one of us (Arnold) during her former pregnancy, the opportunity to contrast the methods in use 3 years ago with the present routine for the control of eclampsia was afforded. During her former attack, venesection, purgation, and sedatives were used, but as was then customary, fluids were pushed by mouth, skin, and bowel. Her recovery was slow and associated with mental confusion and many convulsions. The adoption of a rational fluid balance and the methods of prompt dehydration during the last pregnancy made possible not only a quick recovery from the eclamptic state, but the subsequent successful delivery of a living child so much desired but formerly considered impossible of accomplishment.

CASE 12. Mrs. C. H., white, aged 25 years, i-para, was admitted to the Temple University Hospital July 5, 1931, and discharged July 16, 1931. She was having normal, moderately severe labor pains, at 5 to 8 minute intervals (in first stage, spontaneous labor at term). Patient had had no illness since childhood, and no nausea or vomiting or other complaints during pregnancy. She had been regularly under dispensary care since the fifth month. She had had only very slight œdema of the ankles in these 4 months of prenatal care. Blood pressure had also very gradually increased in these four months: February 24, 1931, 120–80; April 13, 1931, 126–80; May 11, 1931, 120–74; May 24, 1931, 130–90; June 15, 1931, 140–90. Urine at no time contained more than a faint trace of albumin and no casts. Patient had been in normal labor for about 18 hours. Diagnosis: breech presentation, well tolerated labor pains. Convulsions had come suddenly, without forewarning complaint or symptoms. During the period of labor, fluid restriction had been removed and the patient had consumed large quantities of water. She at no time complained of headache, dizziness, or vomiting preceding the convulsions. The specific gravity of the urine was 1.019; reaction, acid; cloud of albumin; no sugar; no casts; no red blood cells. The Wassermann and Kahn tests were negative.

There had been 3 convulsions, of the prolonged, severe type. Blood pressure after first convulsion was 155–110. She was given 50 cubic centimeters of a 50 per cent glucose solution intravenously. The second convulsion came 25 minutes after the first. Spinal drainage, as completely as possible, was done immediately after the second seizure. Patient remained unconscious and wildly restless (uterus was in active labor). In 20 minutes, there was a third and much lighter convulsion. Magnesium sulphate, 20 cubic centimeters of 10 per cent solution, was given intravenously. Patient remained much quieter after the third convulsion and was conscious and rational in less than an hour after the last convulsion. Spinal drainage, followed by spinal anæsthesia and breech extraction was done in 2½ hours after convulsions ceased. Child cried at once, was normal, and well developed. Patient was maintained on a greatly restricted fluid intake and mild saline purgation, recovery was rapid, and the condition of the mother and baby was excellent on discharge, 11 days later.

The danger of rapid administration of fluid during labor, in cases in which the urinary output is low, is clearly shown in this case. Patient came to labor at full term, without complaint, or suggestion of complication, except a very moderate gradual rise in blood pressure, amounting to about 25 points in 4 months. Under the stress of labor, and the heat of the season, there was noted, but not measured by the nurses, an unusually large intake of water during labor. The tremendous amount of stored body fluid released during the following 7 days is most striking in spite of the fact that no fluid was given on the day following delivery. The precipitation of cerebral symptoms in the presence of such fluid imbalance during the stress of labor has led us to cite this case as evidence that the principles involved in the water balance of the body should receive most careful attention even in cases in which pre-eclamptic signs are not present, and especially so, *during labor.*

Summary. The illustrative cases presented in this group, include three degrees of convulsive severity, in three different types of patients, at three separate periods of pregnancy. The first, an unusually severe attack, early in the sixth month, with a recurrence in 2 weeks. The second, a moderately severe type, late in the seventh month, in a patient with a questionable nephritis and a history of a former pregnancy terminated by eclampsia. The third, a sudden severe attack, intrapartum, in a patient undoubtedly organically sound. In all of these, it will be noted, that the prompt control of convulsions, early mental restoration, and rapid clearing of other cerebral symptoms, followed the proper application of the dehydration methods herein outlined.

DEDUCTIONS

The foregoing routine treatment, as might be expected, includes methods long known and accepted. In fact, the success obtained in this series has been primarily due to the establishment and prolongation of the temporary benefits formerly derived from such dehydrating measures as purgation, sweating, and blood letting. Our attempt has been to maintain the prompt clinical improvement of symptoms which follows these various methods of dehydration. In attempting to carry out limitation of fluid and extended modified dehydration, it has been necessary to abandon the almost fanatical belief that large quantities of fluids are necessary to "wash out the toxins," and to recognize that many of the "toxic" symptoms are produced by the excessive fluids themselves, inducing a clinical state of "water intoxication" similar to that produced by Rowntree, responsible for some of the fundamental factors in the problem of eclampsia.

Irrespective of the underlying vasospastic-renal-hepatic disturbance there is a superadded "water intoxication" resulting in a clinical type of cerebral hydration and a terminal sequence of events characterized by convulsions, stupor, and respiratory failure. With the control of this factor according to physiological methods now at hand, we believe that the therapeutic art is capable of directing proper treatment toward the underlying etiology. Even in patients with well established chronic nephritis, it has been possible to protect the patient against the almost certain eclampsism by careful management, and watchful attention directed toward the cerebral physiology and water balance.

In spite of the traditional belief that large quantities of fluid are necessary in renal deficiency, it has been well established during the past 5 years, not only in the above group, but in many other types of cases encountered, requiring dehydration and complicated by nephritis, that symptomatic improvement follows fluid limitation, and renal signs of irritation have actually improved or remained stationary during long periods of dehydration. In fact, in over 300 cases inclusive of the epileptic, arteriosclerotic, cardiorenal, prostatic uræmic, and acute toxic infectious states maintained on dehydration, there has been no advance in the renal pathology noted or increased disturbance of renal function. Contrary to what has been popularly believed, 8 to 10 ounces of urinary output per day has been found to be sufficient for proper elimination of solids, provided concentration is possible as evidenced by a high specific gravity of the urine. Blood urea nitrogen has not shown an increase in the presence of dehydration as evidenced by the studies of Thomas (1931) on the post-prostatic uræmic.

In the light of these observations, the arguments in favor of placing a pathologically involved renal system in a state of partial physiological rest has been borne out by clinical experience with other organs such as the lungs,

heart, and the general principles involved in pathological processes confined to the extremities.

To force the renal mechanism to its utmost during periods of decompensation seems as unsound in principle as would be the enforcement of violent exercise on a decompensating heart.

Irrespective of the renal factor, it is evident that the total amount of fluid ingested must find some avenue for escape, to maintain proper physiological relationship throughout the body. The definite avenues of escape are skin, breath, bowels, and kidneys. If renal elimination is demonstrably less than the total intake inclusive of the water contained in ordinary foods, it is evident that skin, breath, and bowels must compensate to maintain the proper balance, or excessive fluid will be retained in the body. The volume of moisture lost through the lungs varies somewhat with the body temperature and respiratory rate, but for clinical purposes remains approximately fixed. The compensatory load is thus placed upon the bowels and skin. If compensation is adequate, no disturbance in water metabolism occurs. The variability of skin function is determined by environmental temperature relations, activity of the patient, and induced physiological states of activity. The character of the bowel movements determines the volume of fluid lost by this route. If diarrhœa supervenes, compensation may be possible for excessive amounts of fluid unable to escape through the usual renal and skin portals of elimination. However, vomiting often is induced through the central mechanisms to promote fluid elimination. With prolonged and excessive vomiting, the acid radicals of the gastric contents are also eliminated from the body, giving rise to an alkalosis and this in turn, as shown by Lennox and Cobb, is a correlary of œdema, bringing forth a state of tissue bound fluid which, if contained within the cerebral mass may be followed by symptoms of headache, dullness, stupor, and convulsions.

Thus, surrounding the problem of water metabolism lies the need for a careful analysis of the relationship between the intake and output of patients with recognized renal deficiency. From a clinical standpoint, it is possible to measure accurately the fluid intake and to establish a diet relatively fixed in its water content, and thus the known quantities entering the body can be readily established. The measurement of urinary output taken in conjunction with the daily weight will establish the relative storage or elimination of fluids ingested. As 16 ounces weighs approximately one pound, the weight gain or loss is almost entirely in terms of fluid. The amount of solid matter lost even in emaciating diseases approximates less than one-tenth of the total. Thus, if a patient whose intake and output have balanced each day, shows signs of gain in weight, it is evident that the fluid derived elsewhere (food, enema, etc.) has been stored within the body tissues, and conversely, with an established fluid intake and output balance, loss of weight indicates a loss of stored tissue fluids through other than renal channels (skin and bowels). This fluid is usually from the interstitial reservoirs but also in catabolic processes, intracellular to some extent (see Gamble, Ross, and Tisdall).

Carbohydrates favor water storage in that the cells of the body on carbohydrate metabolism require two-thirds more water than when maintained upon a protein metabolism. Sodium chloride, it is believed, also favors fluid retention due to the fixed base sodium. Hence, in maintaining a fluid balance in the body, it is important to eliminate excessive carbohydrates from the diet such as sugar, candy, ice cream, honey, syrups, jelly, and preserved fruits, thus leaving the economy to obtain its necessary carbohydrate requirements from the vegetables and starches contained in an ordinary diet. A salt-low diet is maintained by curtailing the use of salt at the table and avoiding salty foods such as chipped beef, pretzels, salted fish, and highly seasoned soups or foods.

Hypertension. As purgation, sweating, and blood letting are all immediate means of dehydration, it is evident that the results obtained by these beneficial clinical measures should be established and prolonged. To permit the refilling of the fluid reservoirs of the body by immediate ingestion of uncontrolled amounts of liquids favors a prompt return of

the initial state. Blood letting is of value as an emergency procedure, but robs the patient of millions of red blood cells, so necessary as the carriers of oxygen to the functioning tissues. The cerebral tissues require large amounts of oxygen. In the presence of anæmia and anoxæmia, not only is function of the brain disturbed and reduced, but permeability of capillaries is increased and tissue œdema gradually supervenes. Oxygen must be maintained at all costs and hence the red blood cells preserved, if possible, as well as sufficient and optimal circulation through the capillaries, so that tissue function may be maintained.

As blood volume remains one of the most fixed values in the body, the withdrawal of a pint of blood is followed within a few hours by a re-establishment of the volume in terms of available fluid. Thus, the patient has been but temporarily benefited from the standpoint of fluid volume and reduced arterial pressure, only to re-establish subsequently the same volume at the expense of a loss of important oxygen carriers as well as protective white blood cells, removed at the time of blood letting. If blood letting is repeated, a secondary anæmia ensues with little actual loss in blood volume.

As the problem of hypertension primarily depends upon three factors, it is necessary to consider them individually in order to direct our clinical methods toward their control and readjustment: (1) blood volume remaining ordinarily at a fixed level is contained within (2) tubes (arteries, capillaries, and veins) of adjustable volume, filled and refilled by an organic pump (3), the heart.

With blood volume as a comparatively fixed quantity, it is evident that arterial tension is dependent upon an efficient heart and the size of the arteries and arterioles which produce the resistance and tension.

Contraction in the size of the arteries and arterioles may be due to arteriosclerosis, vasospastic irritants (drugs, toxins, local mechanical factors), or central vasomotor influences. Thus, in the presence of a diminution in the caliber of the arterial tree, there is consequently a definite shift of blood volume to the venous side, favoring passive congestion and overfilling of the venous bed including the right side of the heart. With the rise in venous pressure, there is a delay in venous return from the brain through the jugulars, and a subsequent delay in elimination of cerebrospinal fluid, favoring initial stages of intracranial pressure and cerebral œdema. With the onset of cerebral œdema and pressure impairment of capillary circulation of the brain, there is a central response to the vasomotor center, giving rise to an increase in general arterial blood pressure as evidenced by the experiments of Forbes and Wolfe (1927–1928). The central vasomotor spasm thus initiated favors a further rise in intracranial pressure due to the superadded general arterial vascular constriction and a vicious cycle is thus induced by the progressive increase in intracranial pressure and general systemic blood pressure (compare with Traube-Rosenstein theory noted above).

The hypertension which has rapidly responded to dehydration in our series, especially on the systolic side, in the majority of cases, can be explained only upon this basis in that the measures directed toward the relief of intracranial pressure and cerebral œdema have reduced the need for a superadded rise in general arterial pressure to overcome the impending cerebral anæmia. In a few cases, little or no response in the blood pressure resulted from these measures and it is probable that the primary factor of hypertension had its origin from the state of the vessels or the presence of some general vasospastic stimulant, rather than intracranial pressure.

Behney (1931) has suggested the possibility of hyperpituitary function during this stage of the pregnancy as being responsible for the vasospastic state, and it is certain that there is much evidence of gross physical changes during the period of pregnancy to favor the view that pituitary hyperfunction with acromegalic tendencies does occur. It is noteworthy in this series that the fundamental underlying vasospastic or toxic condition, whether of pituitary origin or otherwise, has persisted as evidenced by the continued high diastolic pressure that in many cases has not materially responded to dehydration. As

diastolic pressure primarily represents the state of constriction of the arteriole and the peripheral capillary bed resistance, it is evident that though dehydration may protect the systolic range and maintain it outside of the danger zone, there still remains the underlying factor concerned with the vasospastic state, coincident at this period of pregnancy. For all clinical purposes this factor is rarely dangerous to life and may concern us only in relation to its effect upon oxygen dissociation and its availability to the tissues. As the optimum dissociation of oxygen occurs between the pressures of 60 and 40 millimeters of mercury (MacLeod, 1922), it is important in order to maintain an adequate optimal oxygen supply to the tissues, that the diastolic pressure registered in the brachials should be maintained above 60 millimeters mercury and not above 90 millimeters mercury. However, many compensatory factors assist in the proper oxygen relationship in the periphery, provided the carriers (red blood cells) are not reduced to a profound degree.

Blood letting has, therefore, been practiced in this series only in emergencies and blood volume has been temporarily reduced by active purgation associated with intravenous glucose to assist blood volume in obtaining its replenishment from the interstitial storage reservoirs (cerebrospinal fluid, brain, liver, muscles, etc.), repeating purgation so as again to deplete blood volume, requiring it to turn to the tissue reservoirs for its source of readjustment rather than to fluids ingested and thus easily obtained. Hence, the rationale of fluid limitation and even its complete curtailment during the active period of dehydration in the well advanced type of cases.

Magnesium sulphate intravenously has been advocated as a means of producing dehydration, and there is no doubt that its action is similar to that of glucose in assisting to withdraw the tissue bound fluids into the blood stream where they may be more easily subjected to elimination. Magnesium sulphate is not eliminated through the kidneys, does produce renal inflammation, and for the most part is excreted into the large bowel. In our opinion, several cases of ulcerative colitis may have been precipitated or augmented by the use of this drug intravenously. Although its use is not definitely contra-indicated, 50 per cent glucose has been found to be as effective and has the advantage of being metabolized within the tissues, thus serving a dual purpose as a hypertonic dehydrating solution, and as a factor to combat acidosis, as well as containing definite nutritional values.

SUMMARY

A series of cases have been presented illustrating a method of fluid balance and dehydration in the pre-eclamptic, dangerously threatening, and actively convulsant groups, with and without chronic nephritis as a complicating factor. The results have indicated that the rational, proper balance of fluids has controlled the cerebral symptoms of headache, vomiting, stupor, convulsions, and respiratory disturbances; that systolic hypertension has been favorably influenced; and that the renal function has definitely improved in the majority of cases.

Because of the absence of any mortality in this series or in the cases coming under our care since inaugurating this treatment, and the marked beneficial and prolonged results obtained during the past 2 years, it is our opinion that further continuation and refinement of this method are warranted. Certain fundamental clinical principles long recognized have been placed in a better physiological relationship, and continued maintenance of the former temporary improvements obtained by older clinical methods justify the belief that the condition known as eclampsia is subject to prevention and control along the lines of a properly established water metabolism.

In the analysis of the problem, it is evident that symptoms must be divided into those related to cerebral disturbance secondary to a superimposed hydration state with characteristic responses attributable to "water intoxication," and those symptoms and disturbances which are fundamentally responsible for the initiation of a definite imbalance in water metabolism throughout the body. That a demonstrable toxin is unnecessary for the production of the clinical cerebral signs has been well established by the physiological

work of Rowntree and supported by the clinical observations of many practical obstetricians. In our opinion, eclampsia is probably a *syndrome* rather than a "disease" and takes its origin from a variety of disturbances which produce a common cerebral reaction indicating that no specific etiological cause can be expected to be responsible for the various clinical manifestations of this condition. Thus, by separating the eclamptic state into its cerebral and systemic component parts, it has been possible to direct the treatment toward the cerebral manifestations with strikingly beneficial results.

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PRIMARY CARCINOMA OF THE LUNG

With a Report of a Case Treated by Operation

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UP to a comparatively recent date the rather extensive literature on primary carcinoma of the lung has concerned itself largely with reports of series of autopsied cases. During the past decade the increased evidence of this disease has resulted in a marked renewal of interest, both on the part of the pathologist and of the clinician. It has also given more ample opportunity for study so that ideas as to cell type and histogenesis have to a certain extent become clarified.

The story of primary lung carcinoma has been admirably presented in Adler's monograph and in papers by Weller, Barron, Brunn, Simpson, Fishberg, Grove and Kramer, Eloesser, Moise, and others, and with a reference to these will, therefore, be presented only briefly here.

As early as 1810, pulmonary carcinoma was described in what Ewing terms a vague manner. It was not until 1871 that Langhans presented the first microscopical studies and expressed the opinion that these tumors arose from bronchial mucous membrane. This gave impetus to a search for them in the pathology laboratories so that by the end of the nineteenth century series of cases were being reported. Additional ones have been added until there are now well over 1,000 reported cases, most of which fulfill the requirements suggested by Weller in 1913, in writing of primary bronchial carcinoma; namely, that (1) an autopsy shall have been performed, (2) the carcinomatous nature of the condition shall have been verified microscopically, and (3) there shall be no reasonable suspicion that the lesion is not a primary one.

In 1912, Adler published his monograph on primary malignancy of the lungs and bronchi in which he reported 374 cases, together with notes on the clinical as well as the pathological phases of the problem. He was keenly aware of the advances that had been made in thoracic surgery and of further advances to be hoped for, and made the rather startling recommendation that, when a suspicion of tumor existed and all available means of diagnosis failed, exploratory thoracotomy should be done.

In 1913, Weller, in a study of primary carcinoma of the bronchi, collected 90 cases, discarding some of those previously reported as lacking of sufficient data. At this date he urged the use of the bronchoscope and X-ray in order to arrive at earlier diagnoses. Curiously enough, almost 10 years later Barron sounded a note of warning against bronchoscopy and exploratory thoracotomy with the statement that both procedures were too difficult to be recommended.

INCIDENCE

The undoubted increase of incidence has been commented upon by many writers. This has been attributed to inhalations of gas fumes or dust particles laden with oil or tar products from the streets, to cigarette smoke, and to the residual inflammatory conditions of influenza. Weller felt that the apparent increase might be due to a clearer realization of the frequency and a resultant more careful search and in a later paper, in which he analyzed all available statistics up to 1927, stated that the sharpest rise in frequency occurred about 1910. Others felt that it appeared about 1918 to 1922.

Increased diagnostic acumen and an increasing interest undoubtedly account for some of the additional cases but are hardly responsible for so great a change in incidence. Definite and accurate information will be obtained only by the compilation of such figures as appear in Simpson's report from the London Hospital. Here is presented an analysis of the hospital statistics which shows in comparison of tumors found to autopsies performed a percentage increase from 0.51 in 1907 to 2.05 in 1925. Likewise, in comparing the primary carcinoma of the lung to total

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TABLE I.—LONDON HOSPITAL STATISTICS POST-MORTEM STUDY (AFTER SIMPSON)

Year	Autopsies	Carcinoma of lung	Percentage
1907	1182	6	0.51
1908	1289	10	0.78
1909	1288	8	0.62
1910	1208	7	0.58
1911	1265	5	0.40
1912	905	8	0.88
1913	878	8	0.91
1914	784	5	0.64
1915	719	5	0.69
1916	653	4	0.61
1917	581	3	0.52
1918	615	4	0.65
1919	645	6	0.93
1920	750	8	1.07
1921	598	9	1.50
1922	589	10	1.70
1923	604	11	1.82
1924	578	10	1.73
1925	585	12	2.05

malignant growths found, there was a percentage increase from 1.0 in 1907 to 3.7 in 1925. These figures are so striking that Tables I and II are reproduced.

The statistics from most hospitals where large series have been collected show a similar increase, but in most instances the figures of a great many years are grouped together so that the story is not so vividly portrayed. In this series, as may be seen, the most rapid increase occurred from 1918 to 1922.

PATHOLOGY AND HISTOGENESIS

Theoretically, primary lung carcinoma may arise from the lining of the bronchi, the bronchial mucous glands, or the alveolar epithelium. Confusion has arisen because of several misinterpretations. It now seems fairly clear that many of the lung tumors which have been diagnosed as sarcoma were carcinoma of the undifferentiated cell type and that sarcoma of the lung is an extremely rare condition as pointed out by Weller, Klotz, Ewing, and others. Likewise it is now fairly generally accepted that squamous celled carcinomata may have their origin in the bronchi and do not necessarily arise from alveoli.

Ewing clearly describes three types of lung carcinoma, according to histogenesis. First, those arising from the bronchial epithelium. These are composed for the most part of squamous or cylindrical cells. With the former the structure is usually quite uniform throughout, while with the latter a great variety of histological pictures occurs. Obstruction of bronchi leads to the secondary changes of atelectasis, bronchiectasis, and abscess formation. Necrosis of the tumor mass may also occur as the blood supply becomes inadequate. Second, those arising from the bronchial mucous glands. This type is usually found in the wall of the bronchus. The structure tends to be gland-like and is composed of small cuboidal or polymorphous cells. In some instances the acinar structure may be obscured by tumor cells producing finger-like processes. Variations from the typical structure are frequent. Third, those arising from the alveoli. These may be either diffuse or multiple and nodular. In this type the air vesicles may be completely filled with masses of cells of cuboidal, cylindrical, or squamous form with varying grades of obliteration of the vesical walls, or dilated vesicles may be partly filled with papillary projections composed for the most part of cylindrical cells.

While admitting the theoretical conception of possible origin from the three sources, Simpson points out that the polymorphism of the cells usually makes such a division impossible. In this he is in accord with Weller.

It is concerning the third group that most discussion has arisen. Weller has said that of 14 cases studied, in none was there more than presumptive evidence of alveolar origin and that this was on the basis of the presence of chronic fibroid pneumonia at the apparent site of origin. He states that both the most fully and the least differentiated types may be found in close relationship to main bronchi and that all the intermediate forms may be arranged in a logical series. He feels that the type of cells of which the tumor is composed is much more an indication of its differentiation than of its precise histogenesis. Moise concurs in this feeling and states that in general it is impossible to determine the exact site of origin, but that gross and microscopical evidence points strongly to a bronchial origin for most of the tumors.

Part and possibly all of the difficulty of exact determination of histogenesis arises from the occurrence of metaplasia in the

bronchial epithelium in the presence of inflammation. Moise pointed out that both the bronchial and alveolar epithelium of patients dying of influenza showed striking and atypical proliferative changes resembling carcinoma. It is not unreasonable to suppose that other irritants might produce similar alteration. Another confusing factor is the finding of various cell types in a single tumor.

ETIOLOGY

As with carcinoma elsewhere in the body, the cause of that in the lung is unknown. A number of etiological factors, however, have been suggested. Ewing states that the chief one of these is tuberculosis and cites the appearance of neoplastic growths in diseased lung tissues. In this Barron concurs to a certain extent in that he believes that the increased incidence is probably due to forerunning inflammatory conditions, the most important of which is tuberculosis. In Adler's series of 374 cases only 19 had evidence of tuberculosis. Of the 282 cases reported by Ferenczy and Matolcsy, 44 showed healed lesions at the apices, calcareous bronchial glands or, occasionally, old cavities. Only one showed evidence of active tuberculosis. In a series of 246 cases, Kikuth found some evidence of tuberculosis in 22 but did not consider it of etiological importance. In Simpson's 139 cases from the London Hospital, 47 showed some evidence of tuberculosis, but in only 6 was it an active pulmonary type. Of the four larger series, then, with a total of 1,041 cases only 132, or 12.6 per cent, showed any evidence of tuberculosis and of these only a small portion had active pulmonary lesions. Grove and Kramer, in reporting 21 cases, found tuberculosis present in only 1, in spite of the fact that the series was presented from a large county hospital where the patients ordinarily ran a fairly high incidence of tuberculosis. From these observations one would conclude that the etiological relationship of the two conditions is not great.

Cherry has expressed an original view of the inter-relationship of these two diseases. He believes that carcinoma attacks in later life those who have overcome tuberculous infection in earlier years and considers that the acquired resistance to tuberculosis is the predisposing cause of cancer. He also points out that the sum total of deaths from tuberculosis and carcinoma has varied little in the past 30 years and constitutes 20 per cent of the causes of death after the age of 25. While interesting, this opinion is wholly the result of interpretation of statistics and lacks scientific data for its establishment.

TABLE II.—COMBINED CLINICAL AND POST-MORTEM STUDY OF LONDON HOSPITAL (AFTER SIMPSON).

Year	Total malignant neoplasms	Carcinoma of lung	Percentage
1907	607	6	1.0
1908	618	13	2.1
1909	753	14	1.9
1910	724	12	1.7
1911	814	15	1.8
1912	708	11	1.6
1913	750	17	2.3
1914	835	13	1.6
1915	878	17	1.9
1916	663	14	2.1
1917	866	9	1.0
1918	666	17	2.6
1919	753	18	2.4
1920	744	20	2.7
1921	682	24	3.5
1922	720	22	3.1
1923	777	31	4.0
1924	744	28	3.8
1925	830	31	3.7

It was suggested by Winternitz, Wasson, and McNamara in their study of the pathology of influenza that it might not be unreasonable to expect an increase in pulmonary carcinoma to follow the epidemic. Moise feels that the proliferative changes which occur in the lungs of those dying of influenza, previously alluded to, suggest the possibility of a causal relation between the two conditions. While expressing no definite opinion in this regard, Simpson points out that the sharpest increase of incidence in his series of 139 cases occurred from 1918 to 1922 and feels that this fact in itself might lend some credence to the theory of cause and effect between the two conditions. Others noted the peak of incidence before the influenza epidemic and felt that no relationship existed.

The inhalation of tar products with dust from the streets has been suggested by Staehelin as a possible cause of lung carci-

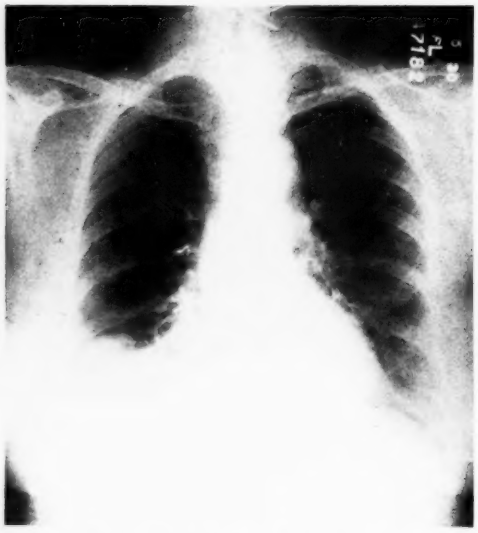

Fig. 1. X-ray plate taken April 29, 1930, showing the tumor mass in the right base directly above the diaphragm.

noma but proof is lacking. However, Simpson points out as suggestive the fact that, in Hong Kong and Singapore where the roads are not tarred, carcinoma of the lung is very rare. He feels that the known potentialities of tar as an irritant, together with its wide use in treating roads, present a problem worthy of scientific investigation.

The inhalation of oil, chemical fumes, and cigarette smoke has also been mentioned as a possible cause but no proof is available.

The theory of inhalation irritative etiology may be given some credence from the fact that these tumors occur from three to four times as frequently in men as in women.

No discussion of etiology would be complete without mention of the Schneeberg tumors. For many years, the mines in the region of Schneeberg in Saxony have been productive of a radioactive ore containing iron, bismuth, tin, zinc, lead, manganese, uranium, cobalt and nickel, in combination with sulphur and arsenic. It was long ago recognized that a great many of the mine workers developed lung diseases from which they sooner or later died. As early as 1879, Harting and Hesse reported that 79 per cent of the deaths occurring among the miners were due to a pulmonary condition which they described for the most part as a lymphosarcoma involving the bronchial glands. They collected data for a period of 9 years from 1869 to 1877. The average number of men employed during this time was 650 and during this period 150 died, usually in an emaciated state bordering on cachexia. In 1913, Arnstein suggested that possibly many of these cases were tuberculosis or pneumoconiosis, and this opinion was apparently partly substantiated by Saupe who concluded that the conditions were in part pneumoconiosis and in part actual lung malignancy. These reports led Barron to state that these tumors were no longer used in arguing in favor of an irritative cause and were now considered as inflammatory conditions. As a matter of fact, a commission has subsequently again studied the condition, and the conclusions arrived at and reported by Schmorl, in 1923, and by Schmorl and others, in 1924, substantiate the earlier belief that these tumors are in reality carcinoma. A group of 154 miners was observed over a period of three and a half years. In this time 21 of them died and of these 13, or 62 per cent, were diagnosed at autopsy as having primary carcinoma of the lung. If two, who had been out of the mines several years, are excluded, the percentage is 52. During this same period 362 non-mine workers were also observed and no evidence of carcinoma was found. Schmorl, therefore, concluded that pulmonary carcinoma was still endemic in this region and that the condition was a true epithelial new-growth.

In this instance, the possible causes are many. The dust itself may be a factor. Added to this is the chemical effect of the various ingredients of the ore, particularly of the arsenic. Perhaps the radioactivity and the fungi which grow in the mines are causative factors.

It would seem not unreasonable to suppose that possibly all of the suggested causes may have some influence, and that as Weller predicts, the condition may be found to be "due to (1) an inheritable intrinsic predisposition which may be activated by (2) a variety of chronic irritative factors. These may be

Fig. 2. X-ray plate taken April 29, 1930, in the lateral position. This shows the tumor mass less distinctly in the posterior portion of the thorax.

mechanical, chemical, bacterial, thermal, or radioactive, but they have in common the ability to incite proliferation in certain cells, regeneration, repair, hyperplasia and often metaplasia."

SYMPTOMS

The symptoms vary with the location of the tumor and with its size and duration. It is clear, therefore, that a constantly changing clinical picture exists and that no symptom complex can be laid down as pathognomonic. Weller analyzed the records of 100 cases in an effort to clarify the direct relationship of physical signs and symptoms with the pathology found. The symptoms which he enumerates are in the main those noted by others. Cough, pain, sputum, at times blood stained, and dyspnœa are the four most common ones due to the primary local pathology. Less frequently and later appear cyanosis, dysphagia, stertor, and pleural effusion.

Mediastinal involvement, in the order of frequency, produces cough, pain, dyspnœa, cyanosis, venous engorgement, recurrent laryngeal paralysis, hoarseness, inequality of the pupils, inequality of the radial pulse, abdominal pain, dysphagia, and stertor.

Fig. 3. X-ray plate taken June 24, 1930, following operation showing narrowing of right thorax, clouding of entire right side.

General systemic effects, which usually appear only late in the disease, are loss of weight, weakness, osteo-arthropathy, fever, chills, cachexia, anorexia, and nausea and vomiting.

The signs and symptoms of metastatic tumors other than those of the mediastinum vary with the part involved, the most pronounced being those referable to the central nervous system.

METASTASES

In this connection it must be borne in mind that the metastatic tumors not infrequently give rise to symptoms in the new location before the original site is suspected of disease. All observers are agreed that metastatic spread occurs widely and in many instances very early. Weller states that tumors composed largely of columnar or of undifferentiated cells metastasize widely and early while the cornifying squamous cell type spreads chiefly by local extension, with late metastases to the regional lymph glands. The non-cornifying squamous cell type acts similarly, although somewhat less restricted than the other variety.

Adler's collected series of 374 and Simpson's series of 139 from the London Hospital show a fair uniformity of distribution of metastases. By far the most frequent are those in the regional lymph glands. Fre-

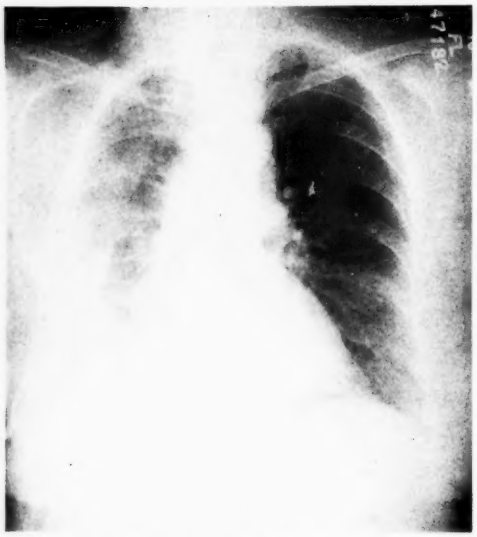

Fig. 4. X-ray plate taken February 10, 1931, showing hazing over entire right side, especially at the base. The hilus shadows are about as appear in earlier films.

quently involved, also, are widely scattered portions of the skeletal system, the liver, and the lungs and pleura. Metastases to the brain are not uncommon. Those to other organs or parts of the body are less constant but not infrequent.

COURSE

From a study of many reported cases it is obvious that the duration of illness is extremely variable. In some a rapid downhill course occurs, with death within a few weeks or months of the onset of symptoms. In a few instances it seems fairly clear that the condition existed for as long as 3 or 4 years after the appearance of the initial symptoms. A surprisingly good state of health may exist in the presence of these tumors with loss of weight and cachexia appearing only in the late stages of the disease. The duration of life will depend largely upon the complications which occur and on the extent and location of the metastases.

The obstruction of a bronchus by tumor with resultant atelectasis and bronchiectasis not only changes the clinical and X-ray findings but with the added intrathoracic suppuration the symptoms become more pronounced and the course more rapidly downhill. In fact not a few of these cases have been treated with the thought that the secondary condition was the primary one, the latter being discovered only at autopsy.

DIAGNOSIS

The diagnosis of primary carcinoma of the lung in its early stages is rarely made, largely because of the insidious character of its onset. It is only by constantly bearing in mind such a possibility that early diagnosis may be made. The clinical data are of immeasurable value but with a constantly changing condition no criteria may be laid down. The history is often suggestive, with the dry cough gradually becoming productive of slightly bloody sputum. Pain in the chest, while helpful in directing attention to this area, is not especially characteristic. The roentgenogram is of the greatest aid, especially if the tumor is discreet and well out from the hilus, and should be made with the chest in various positions. The use of lipiodol injection into the bronchus will sometimes outline a tumor which is otherwise obscure but is not to be entirely relied upon because of the technical difficulties and because various grades of encroachment upon the lumen of the bronchus may give variable results.

As with any intrathoracic diagnostic problem, suppurative or neoplastic, with the possible exception of uncomplicated empyema, bronchoscopy is frequently of the greatest assistance. While this has not been widely practiced until comparatively recently, as early as 1910, Rénon, Géraudel, and Marre, reported making a diagnosis of squamous cell carcinoma of the lung from a bit of tissue removed from the left lower bronchus with the bronchoscope. It is largely with the use of this instrument that earlier diagnoses may be made.

Lilienthal has been an advocate of exploratory thoracotomy and biopsy in those instances in which a diagnosis of intrathoracic pathology cannot be otherwise established. This seems a justifiable procedure, for with improvement in anæsthesia and in methods of approach, opening of the chest need not be attended with more danger than that which

accompanies any major operation. In this connection also, Adler's far-sighted recommendation is to be recalled.

The presence of a bloody pleural effusion not otherwise accounted for is strongly suggestive of intrathoracic malignancy, but in such a case the condition has usually already reached a hopeless stage.

TREATMENT

The treatment to be recommended depends, of course, upon the extent of the growth at the time the definite diagnosis is made. For tumors which have already gone well beyond their original confines, palliative treatment of symptoms is almost all that remains to be done. In fact many writers dismiss the question of treatment with the above suggestion, stating that so far as it is concerned the condition is hopeless. The recent increase in frequency and advances in thoracic surgery have brought renewed interest from clinicians and this in turn renewed efforts toward some curative procedures. Brunn collected reports of 28 cases in which operations had been performed and reported two of his own. On many of these the operations in themselves accomplished little, because of metastases already present or because of inaccessibility which made complete removal impossible. Included in this group, however, were 5 cases in which Sauerbruch operated, and 2 of the patients were still alive and apparently well, 5 years and the other 3 years after operation. In some others a fatal pneumonia supervened when it was thought a complete extirpation may have been accomplished. In other instances patients lived for as long as a year and a half before metastatic tumor or local recurrence brought about a fatal termination.

Harrington has recently reported operations on 14 patients with intrathoracic malignancy. Of these, 6 were diagnosed as sarcoma, 2 as endothelioma, 4 as adenocarcinoma, and 2 as squamous cell epithelioma. Six of these patients apparently had carcinoma which originated in the lung. Of these, 2 on whom partial lobectomy was done were alive less than a year after operation. Two others had partial lobectomies for adenocarcinoma and died in less than a year of recurrence. Of 2 patients with endothelioma, 1 survived less than a year and the other more than 2 years.

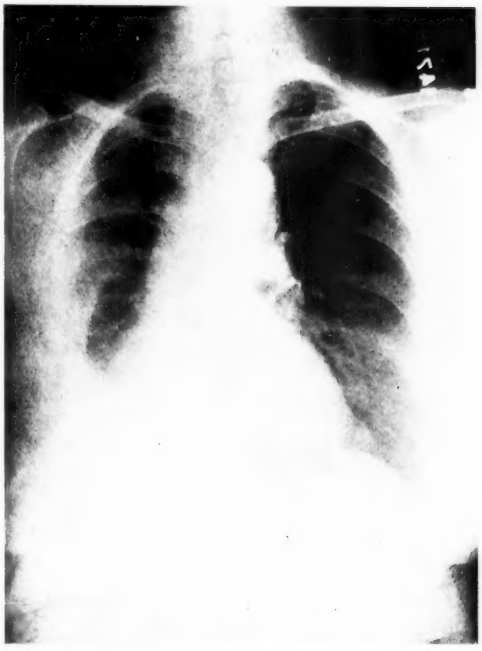

Fig. 5. X-ray plate taken August 12, 1931. The hazing of the right thorax persists and there are no signs of recurrence or of metastases.

These results, meager as they are, have changed the condition from one of absolute hopelessness, to one in which at least some effort may be made if operation is done reasonably early. As Weller has said "the stage at which carcinoma of the lung is diagnosed has already been moved back from the autopsy room to the last few months of life." This, of course, is not always true but it indicates some progress.

For tumors located well out in the periphery or midportion of a lobe, extirpation of the tumor or a lobectomy, after a wide exposure would seem to offer the best chance for a cure. It is only reasonable to consider that at some stage no metastases have occurred and that removal of the tumor will eradicate the disease. The crux of the matter lies in an early diagnosis. Whether keener observation and

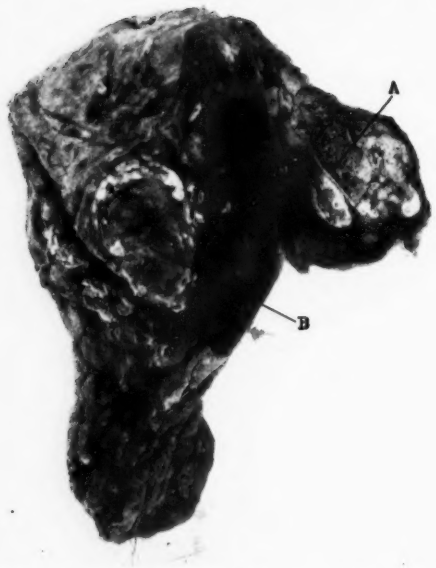

Fig. 6. Photograph of removed lobe. Incision has been made through lung and tumor and portions held apart. On right may be seen tumor invading the bronchus, *A;* on the left the main portion of tumor, *B*.

more adequate use of mechanical assistance will bring this about will provide an interesting study some years hence. As pointed out by Graham the radical operation offers scant hope of cure at present because of the advanced stage at which the diagnosis is usually made.

The cautery lobectomy has been used in a few instances where resection was not feasible. It would seem to be most applicable in those cases in which the tumor had spread into an adjacent lobe or where infection has supervened as so frequently follows the obstruction of a bronchus.

Vinson has recently briefly reported some results from the use of radium and deep X-ray therapy in bronchial carcinoma. Of 10 patients observed over periods varying from 4 months to 3½ years, 6 were reported as failing rapidly, 2 were not heard from, and 1 was reported as apparently well. This last one had had treatment both with radium and X-ray 3½ years previously and the writer felt that this type of therapy should be adopted. Others are strongly of the opinion that this type of treatment has been of no value.

REPORT OF CASE

We present herewith a report of a case of primary carcinoma of the lung on whom operation was performed following the establishment of the diagnosis by bronchoscopic biopsy.

A. S., a white woman, aged 65 years, was referred to one of us (F. J. S.) April 29, 1930, by Dr. John Nagle with a history of having had a slight irritating cough for the preceding 3 years. The onset of the trouble was dated as following a course of Pasteur treatment for dog bite. Shortly after the onset of cough she began to have some mucoid sputum which had never become purulent but which for the 2 to 3 months preceding her coming to the hospital had at times been pink stained. For the preceding 6 months she had been uncomfortable when lying on her right side and for the preceding 2 months this symptom had become considerably aggravated. At the time Dr. Nagle was consulted the sputum was found negative for tubercle bacilli but an X-ray taken in April, 1930, revealed a rounded shadow at the base of the right lung.

On admission to the hospital, she appeared to be in good physical condition and, in fact, aside from a moderate hypertension and the findings in the right chest, the examination was essentially negative. The examination of the chest revealed nothing remarkable in the left lung. On the right side, a slight impairment of the percussion note with a diminution of the breath sounds was noted at the base. Both lung bases descended well and equally and the chest wall moved freely on both sides. No râles were heard.

Examination of the heart was negative.

Abdominal examination was negative except for slight tenderness over the gall-bladder area. The liver edge could be felt on deep palpation, was smooth and not tender.

X-ray films of the chest revealed an oval shadow of increased density lying apparently in contact with the diaphragm. Films in the lateral position showed the shadow lying just posterior to the highest portion of the diaphragm. On fluoroscopic examination, the shadow descended with the diaphragm on deep inspiration and could not be separated from it by changing positions.

The possibility of the condition's being an echinococcus cyst was considered and 1/10 cubic centimeter of echinococcus fluid was injected intradermally without reaction.

The sputum was negative for tubercle bacilli but contained streptococcus viridans, hæmolytic streptococcus, and staphylococcus. The red blood count was 4,500,000; white blood count 7,600; and hæmoglobin content 90 per cent. The blood Wassermann

reaction was negative. The urine and stool analyses were negative.

On May 5, a bronchoscopic examination was done by Dr. George Kreutz. The instrument was passed directly into the right lower bronchus and as the terminal portion of this was approached a red fungating mass of a raspberry appearance was visualized. The marked bronchial irritation did not permit the taking of a specimen. On May 9, bronchoscopic examination was repeated and a bit of tissue easily removed from the tumor mass. Dr. F. W. Hartman examined this tissue and described it as being composed of groups of mucous glands with masses of large oval and cuboidal cells having no particular arrangement. The cells had large hyperchromatic nuclei but these were not abundant. The diagnosis was primary carcinoma of the lung of the undifferentiated cell type.

With the diagnosis established and with no signs of metastatic tumors, an exploratory thoracotomy was advised, with the idea of resection of the involved lobe if this proved feasible.

The patient was discharged from the hospital and was readmitted for operation May 26. On May 28, after another 48 hour period of observation, the first of the two stage operation was performed. At this time portions of the sixth, seventh, eighth, and ninth ribs on the right side were resected, through an incision beginning in the midscapular line and running downward and laterally to the midaxillary line. The soft tissues were retracted, and with the lung kept well expanded by increasing the pressure of the ethylene and oxygen mixture, the thorax was opened. The lower lobe could be easily palpated and in its midportion there was felt a round firm mass about an inch and three quarters in diameter completely surrounded by lung tissue and entirely free from the lobe above and from the diaphragm below. The parietal pleura was slightly scarified with gauze on the finger to promote formation of adhesions; the pleura of the middle lobe sutured to the parietal pleura by a row of interrupted plain catgut sutures and the wound closed in layers. It seemed quite likely at the time that resection would be possible.

Following the operation the patient suffered a fair amount of shock. The pulse rate rose to 120 per minute and the temperature to 100.4 degrees. A transfusion of 650 cubic centimeters of citrated blood was given with considerable improvement. The patient continued to have considerable discomfort in the chest with some respiratory embarrassment but by the eighth day after operation the temperature and pulse rate were normal. On the twelfth day after operation the second stage of the operation was performed. Under nitrous-oxide gas and oxygen anæsthesia the wound was opened. About 300 cubic centimeters of slightly bloody fluid was evacuated. The upper portion of the chest was only partially sealed off by fragile adhesions and these also surrounded the lower lobe. With the lung kept moderately well expanded by the gas, the lower lobe was held in the palm of the hand, and the root of the lung was visualized. With the fingers and thumb placed well beyond the tumor, the pedicle was crushed in three portions and cut across with the radio knife. Each portion was then transfixed and ligated with chromicized catgut. The end of the stump was treated with electrocoagulation and its two outer portions then sutured together over the midportion. A single rubber tube was brought out through the chest wall through a small stab wound below the incision and the incision was closed in layers. The air was evacuated and the end of the tube placed in a water seal. The patient was in considerable shock on returning to her room. This was somewhat relieved by a blood transfusion. The respiratory embarrassment which was considerable was greatly relieved by placing the patient in an oxygen tent. While the immediate reaction was somewhat stormy, the convalescence was on the whole quite good. The temperature ran an elevation of 1 to 2 degrees for about 6 weeks after which it remained approximately normal. Recovery was complicated somewhat by an arthritis of the right shoulder, wrist, and hand so that getting the patient on her feet again was a somewhat drawn out process. During this time the lung had gradually expanded to occupy the dead space; the tube had been removed, the wound being well healed. The patient discharged September 8, 3 months after the last operation, having been afebrile for preceding month.

Fig. 7. Photograph showing the scar of operation extending from midscapular to midaxillary line.

Three weeks after returning to her home she developed a swelling and redness of the operative scar

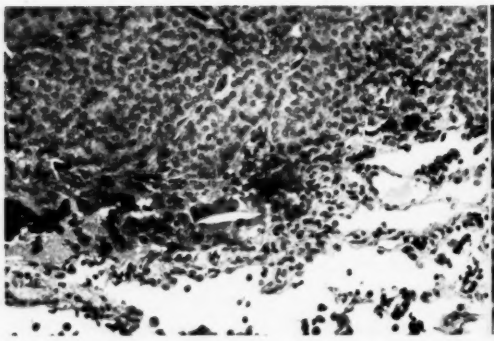

Fig. 8. Low power photomicrograph showing the lung invaded by alveoli of small undifferentiated tumor cells.

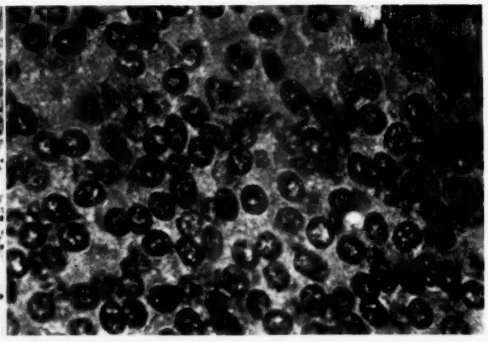

Fig. 9. High power photomicrograph showing the character of the individual tumor cells.

and was again admitted to the hospital. A small empyema pocket was found and was treated by the introduction of a tube and irrigation with Dakin's solution. There was no febrile reaction associated with this complication; it cleared up promptly and the patient was discharged from the hospital after 10 days.

The progress since then has been satisfactory. When examined recently, 14 months after the last operation, the scar was in good condition and had fallen in somewhat. There was considerable limitation of movement on the right side. The vocal fremitus and percussion note were somewhat diminished below the angle of the scapula and the breath sounds were distant. No râles were heard. There was a slight displacement of the heart to the right. X-rays of the lungs which were taken at this time showed a slight hazing over the entire right chest, but there were no signs of recurrence or of metastasis.

Clinically the patient is well. Her cough has been entirely relieved and there is no sputum. She has gained weight and is pursuing her usual occupations as a housewife.

NOTE.—Patient was last seen in May, 1932, and progress was entirely satisfactory. She is having no symptoms referable to the respiratory system, is carrying on her daily activities as a housewife, and so far as we have been able to determine there are no signs of metastases or of recurrence.

CONCLUSIONS

The interest in this condition of those engaged in clinical work has in the past been more or less cursory. On the other hand, it has offered a great field for study by pathologists.

It is, as yet, entirely too early to anticipate the probability of a cure in this instance. We can only say that for 14 months the patient has apparently been cured. Had the condition been diagnosed while the tumor was much smaller, we should feel much more optimistic about the final outcome. The hopeful circumstance, so far as these tumors are concerned, lies in the fact that in some instances they can be successfully removed, even in elderly individuals. The chances for a complete cure will depend on the location in the lung and the making of the diagnosis before metastases have occurred.

The advances in roentgenography and the use of the bronchoscope in expert hands have made earlier diagnoses possible. Bronchoscopy cannot be too highly recommended as an aid in arriving at a diagnosis in any obscure lung condition.

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RESPIRATORY COMPLICATIONS FOLLOWING GENERAL ANÆSTHESIA

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THIS report is based on 6,619 operations in which general anæsthesia was used. The data are taken from the records of the Presbyterian Hospital, Chicago, and cover the period from January 1, 1921, to December 31, 1930. [1]

Sex. In 3,258 operations the patients were males; in 3,361, females.

Age. The ages of the patients ranged from 2 hours to 92 years.

The anæsthetic. One thousand four hundred and fifty general anæsthesias fall into the period before the discovery and clinical use of ethylene in April, 1923. The technique used during this time was nitrous oxide gas and oxygen induction followed by drop ether or ether only for infants, with no preliminary medication. From April, 1923, to the end of the year 1930, 5,169 general anæsthesias were given. In 2,620 cases, ethylene was used alone; in 2,245, ethylene and ether were used; in 14 cases, local and ethylene; in 82 cases, ethylene and local and ether; in 98 cases, nitrous oxide gas and oxygen; and in 110 cases, nitrous oxide gas and ether.

Preliminary medication has been used since 1923. The following drugs, in the order named, were the most frequently employed; morphine, morphine and atropine, pantapon, rarely morphine and scopolamine.

Respiratory complications. Sixty-three patients developed respiratory complications following these 6,619 operations. Forty-five were males, 18 were females. Thirty-one of these patients recovered, 32 died. These figures represent a morbidity percentage of 0.95 and a mortality percentage of 0.48 for the total series of 6,619 operations.

All patients in whom any lung complications developed within 30 days following the operation have been included. Many observers claim that respiratory complications due to the anæsthetic occur within 24 hours. No attempt has here been made to separate those due to the anæsthetic from those due to other causes.

Thirteen of the cases of respiratory complications, with 4 deaths, were in the 1,450 cases before April, 1923, when ethylene began to be used; 50 cases, with 28 deaths, occurred in the 5,169 cases of the later period (Table I). (The corresponding percentages are 0.89 and 0.96 for the morbidity; 0.27 and 0.54 for the mortality.)

TABLE I.—ANÆSTHETIC AGENTS USED

Pre-ethylene		No. lung complications	Recovered	Died
49	Ether only	4	1	3
144	Nitrous oxide and oxygen	3	3	..
1257	Nitrous oxide and oxygen and ether	6	5	1
1450		13	9	4
2620	Ethylene only	21	9	12
2245	Ethylene and ether	18	10	8
14	Ethylene and local	2	1	1
82	Ethylene and local and ether	1	1	..
98	Nitrous oxide and oxygen	2	0	2
110	Nitrous oxide and ether	6	1	5
5169		50	22	28
Total		63	31	32
6619				

During this period 218 operations were performed on the breast, 114 on the vagina, and 604 tonsillectomies with no respiratory complications. In 240 diabetic patients, 8 developed lung complications, 5 who had bronchitis recovered and 3 died, one of lobar pneumonia, one of pulmonary embolism, and one of bronchopneumonia.

Thirty-nine of the 63 respiratory complications occurred in the months from October to March.

From the standpoint of age, it may be of interest to note that the oldest patient of the total series (aged 92 years), who had nitrous oxide gas and oxygen for drainage of an appendiceal abscess, did not have any respiratory complication, while the youngest patient (a two hour old infant), who had ether anæsthesia lasting 40 minutes for repair of a large ventral hernia, developed bronchopneumonia 3 weeks after the operation and died on the twenty-ninth day.

[1] These anæsthetics were given on the services of Drs. Lewis, Phemister, David, Kretschmer, Moorehead, Herbst, McGinnis, Montgomery, Miller, Oberhelman.

Complications with recovery. The 31 respiratory complications with recovery comprise one case of lobar pneumonia, 5 cases of bronchopneumonia, 21 cases of bronchitis, and 4 cases of pulmonary embolism.

Twenty-two of these were in males, 9 were in females.

The ages of the patients, according to decades, are shown in Table II.

TABLE II.—AGES IN DECADES—RESPIRATORY COMPLICATIONS, RECOVERY

	Cases
First decade	1
Second decade	2
Third decade	2
Fourth decade	5
Fifth decade	6
Sixth decade	7
Seventh decade	4
Eighth decade	4

In 12 cases the operation was on the upper abdomen.

Sixteen of the cases occurred between October and March.

Pre-operative cardiac pathology was present in 4 cases; pre-operative pulmonary pathology, in 3 cases.

Complications resulting in death. The 32 respiratory complications with fatal ending comprised 3 cases of lobar pneumonia, 20 cases of bronchopneumonia, 7 cases of pulmonary embolism, and 2 cases of pulmonary œdema (at autopsy the cases of œdema showed healed tuberculous scars in one and chronic nephritis in the other).

Autopsy was performed in 13 cases and confirmed the clinical diagnosis. In 4 of these, thrombi were found in locations other than the lungs (in the veins of the leg, scrotum, inferior vena cava, and the periprostatic veins). Twenty-three of the patients were males, 9 were females.

The age distribution is shown in Table III.

TABLE III.—AGE DISTRIBUTION OF RESPIRATORY COMPLICATIONS—DEATHS

	Cases
First decade	3
Second decade	2
Third decade	3
Fourth decade	1
Fifth decade	4
Sixth decade	11
Seventh decade	7
Eighth decade	1

TABLE IV.—SUMMARY OF COMPLICATIONS

	Recoveries	Deaths
Lobar pneumonia	1	3
Bronchopneumonia	5	20
Bronchitis	21	0
Pulmonary œdema	0	2
Pulmonary embolism	4	7
Total	31	32

In 10 cases the operation was on the upper abdomen.

Twenry-three of the 32 cases occurred between October and March.

There was pre-operative cardiac pathology in 15 cases, pre-operative pulmonary pathology in 5 cases, and pre-operative cardiac and pulmonary pathology in 4 cases. Lesions of the heart or lungs or of both heart and lungs had thus been present before operation in 24 of the 32 fatal cases, as compared with 7 of the 31 non-fatal cases of respiratory complications.

It may be noted further that 19 of the 32 patients who died of respiratory complications were over 60 years of age; that 7 of 8 patients with bladder or prostate lesions were over 68 years old, and that 5 had elevated temperatures at the time of operation.

Statistics from other hospitals. Recent statistics in the literature are in many instances not wholly comparable for the reason that they are confined to certain types of operations, to certain kinds of anæsthesia, or to certain respiratory complications.

Patey combined the statistics from 31 London hospitals for 1926 and found that in 54,253 operations there were 50 cases of pulmonary embolism, a percentage of 0.09. Forty-three cases followed abdominal operations.

Aikenhead quotes Armstrong's report of 2,500 major operations in Montreal, with postoperative lung complications in 2.2 per cent; Featherstone's report of 222 gastric operations in Birmingham (England), with a morbidity of 10.8 per cent; Whipple's statistics from the Presbyterian Hospital of New York: 3,719 operations with development of lung complications in 2.3 per cent; and Elwyn's 299 operations under some form of local anæsthesia at Mount Sinai Hospital, New York, with pulmonary sequelæ in 2.7 per cent.

The figures of Stahnke from the Brandenburg Clinic at Berlin show respiratory complications after 3.5 per cent of vaginal operations, after 14.2 per cent of laparotomies, 10.35 per cent of prostatectomies, 9 per cent of appendectomies, and 14.8 per cent of hernia operations.

Fuller analyzed the surgical records of University College Hospital, London, for the year 1927 and found 124 pulmonary sequelæ in 1,478 cases, a percentage of 8.3 per cent; the mortality was 1.8 per cent. There were 75 cases of bronchopneumonia, a larger number, he pointed out, than in any of the recently published series. In most of the cases of bronchopneumonia, the onset was on the first or second day after operation; a few cases began on the third day, 1 on the fifth day. The series contains 9 cases of infarction; this complication, he says, never occurs before the seventh day.

Etiology. The exact process leading to the different types of respiratory sequelæ of surgical operations seems to be unknown. The anæsthetic agent in itself does not appear to be the determining factor, since these complications have occurred following local, spinal, rectal, and various forms of inhalation anæsthesia. Stahnke claims a higher mortality from lung complications after gynecological operations when spinal anæsthesia is used. Mikulicz (cited by Aikenhead) asserts that lung complications occur as frequently after local as after general anæsthesia. It has not been shown that the length of the operation is a factor.

The site of operation, on the other hand, appears to be important. The percentage is high for laparotomies. This cannot be held to be due to operative shock, since Stahnke's figures quoted are high for prostatectomy, appendectomy, and especially so for herniotomy. In Aikenhead's series more than half the respiratory complications followed gastrointestinal operations including hernias.

Irritation in and about the structures supplied by the vagus is thought to be important and the fact that a large proportion of the operations followed by pulmonary complications have been upper abdominal operations supports this view. In Fuller's series, 181 upper abdominal operations accounted for 41 lung complications, 22.6 per cent; whereas 429 lower abdominal operations were followed by pulmonary complications 47 times, only 10.9 per cent. In the present series, 22 of the 63 surgical interventions that gave rise to respiratory complications were upper abdominal operations. Nine were lower abdominal operations.

It is probable that pressure on the diaphragm from the Trendelenburg position maintained for a long time plays a part in producing lung complications. Saline injections given too frequently or repeated at too short intervals are another probable factor; Moynihan claims that acute œdema of the lungs may be caused by large saline injections given for shock.

It is Razemon's opinion that the infecting organisms gain entrance by the lymphatic route and pass from the diaphragmatic lymphatics to the thoracic duct and the great veins of the neck, and thence to the right heart to be filtered out by the lungs. Cutler and Hunt hold that infection is carried by small emboli through the lymphatics or by the blood stream from the site of operation to the lungs.

Foss and Kupp believe that embolism plays the chief part in the production of most postoperative pulmonary complications. They affirm that infarctions (minor emboli) are far more common than has been generally supposed. According to published reports, recent years have seen an astonishing increase in thrombosis and embolism in both Europe and America. Numerous theories have been advanced to explain this increase, but none has won general acceptance. Kuhn, of the Institute of Pathology at Freiburg, states that from 1924 to 1927 fatal embolism increased from 1.3 to 4.9 per cent, and that in 1927 thrombosis was found in every fourth body examined, fatal embolism in every twentieth. He thinks that the increase is to be explained by the prolongation of life in patients with chronic disease of the heart. He states also that thrombosis and embolism are three times greater in patients with chronic heart disease after cystotomy preliminary to prostatectomy than after the same operation on patients in good condition. Diaz Sarasola believes that

there exists a familial type, with torpid, adipose asthenic habitus, which is predisposed to thrombosis and embolism. In such a subject, surgery could activate the thrombophilic factors through various means: by the cardiac debility and the hypotension which usually follow operation; by producing changes in the composition of the blood (Diaz Sarasola noted certain morphological, serobacteriological, and physicochemical alterations in the blood of patients after operation, and Walters mentions changes in the cellular constituents of the blood after operation as being seemingly concerned in the origin of emboli); or possibly through noxæ provoking reactions in the endothelial cells of the vessel linings. Efforts have been made, but without much success, to link up the modern practice of intravenous administration of medicines with the increased prevalence of thrombosis and embolism. In Central Europe, war and postwar malnutrition have been blamed. Franke expresses the opinion that the present alarming increase may prove to be a transient phenomenon, bequeathed to the world by the influenza epidemic of 1918–1919, which, he suggests, has left behind a condition of latent infection whose point of attack is the vascular system.

Other probable causes of respiratory complications following operation are: Pre-existing cardiac or pulmonary disease; poor mouth hygiene; cooling-off of the patient; aspiration of stomach contents; decreased expectoration and poor ventilation of lung bases after operation because of pain; disorganization of the abdominal pump mechanism by an abdominal incision producing a tendency to stasis in the splanchnic vessels which predisposes to thrombosis; and pneumostasis from the patient lying continually in the dorsal position. In my experience, bronchitis is more likely to occur in heavy smokers than in those who do not smoke or who smoke only moderately.

Diagnosis. The physical findings in the various lung complications are too well known to be repeated here, and the subject of diagnosis comes within the scope of this paper from only one angle. In reviewing the literature since 1924, one is impressed with the number of contributions dealing with respiratory sequelæ of surgical interventions, and also by the apparent increase in their incidence. Is this increase an actual one or are we examining patients more thoroughly? Heep reminds us that an elevated temperature after operation used to be accepted in most cases as due to the general course of the operative wound, whereas we now know that it is most often caused by lung complications. In respect to the apparent increase in postoperative pneumonia, we may remember what Neuhoff points out: "the diagnosis of pneumonia in very sick patients is fraught with difficulty." Aikenhead reports that of 81 cases that were diagnosed pneumonia clinically and that later came to autopsy, the postmortem examination confirmed the diagnosis in only 51, or 60 per cent.

Prevention. Since postoperative respiratory complications cannot in the present state of our knowledge be laid to the door of any one definite and certain cause, our hope of prevention must lie in meticulous care of the patient before, during, and after the operation. If the patient's heart is already damaged, it must be fortified by digitalis. Henderson found myocardial degeneration and decompensation in 23 of 46 non-surgical cases of pulmonary embolism. Chilling of the patient due to the soap and water preparation and to allowing the patient to remain on a pad that has become wet during this process is a source of danger that is sometimes overlooked. During the operation tissue injury must be kept to a minimum; especially must one use care when removing necrotic areas and hæmatomata.

The circulation requires special thought in the postoperative period. The effect of the operation itself is to tend to decrease the rate of blood flow and to lower blood pressure. Particularly do intra-abdominal manipulations interfere with the circulation. After the operation, the rest in bed and the muscular splinting of the abdominal wall because of pain act to slow down the blood flow. The first steps toward encouraging the circulation are directed toward assuring a sufficient amount of fluid in the vessels to make normal pressure and flow possible. To this end, saline or 5 per cent dextrose solution may be introduced by hypodermoclysis in quantities

TABLE V.—SUMMARY OF STATISTICS

Operations	Cases	Bronchitis		Broncho-pneumonia		Lobar pneumonia		Embolism		Œdema	
		Recovery	Death	Recovery	Death	Recovery	Death	Recovery	Death	Recovery	Death
Brain tumors	28								1		
Laryngeal papilloma fulguration	17				1						
Cleft palate	158				1						
Foreign body—bronchus	32			1							
Thyroidectomy	422	3		1	3						
Mastoidectomy	52								1		
Stomach	155	2			3			1	2		1
Exploratory laparotomy and intestinal	190	2		1	2		1				
Gall bladder	285	5		1	1						
Appendectomy	720	1			1						
Abdomen—gynecology	120				1						
Hernia—including postoperative	390	3			1			2			
Kidney	193	3		1				1			
Urinary bladder	307				2				1		
Prostatectomy	210	1			3				1		1
Kraske	36					1	1				
Rectal	520				1						
Fractures	201						1				
Cellulitis of leg	1								1		
Amputations of leg	82	1									
Total	4119	21		5	20	1	3	4	7		2

Total cases with complications 4119
Cases without complications—
Breast 218
Vaginal 114
Tonsillectomy 604
Outside patients 740
Miscellaneous 824 2500
Total combined 6619

of 500 to 1000 cubic centimeters or by the rectal drip method. In obese patients, on the other hand, and in patients with a tendency to bronchial disturbances, the removal of from 100 to 300 cubic centimeters of blood from the circulation may prove beneficial. Inhalations of carbon dioxide (2.5 per cent) may be given to stimulate the respiratory center, with consequent quicker removal of gas from the blood. The inhalations are continued for from 5 to 10 minutes and are repeated at half hour, one, or two hour intervals. To avoid stasis in the lung bases, care is taken that the patient does not lie too long in the dorsal position. Systematic bed exercises of the arms and legs, started as soon as practicable after operation, have received some attention in recent years.

A large variety of drugs have been recommended in the prophylaxis of pulmonary complications, for their effect on the circulation, on the respiratory center, and on expectoration of mucus from the air passages. The older drugs, such as caffeine, camphor, strychnine, etc., are well known, and my experience with the newer preparations and combinations has not been wide enough to enable me to say anything of value.

SUMMARY

1. In 6,619 inhalation anæsthetics, 63 patients developed lung complications, repre-

senting a morbidity of 0.95 per cent and a mortality of 0.48 per cent.

2. Males are apparently more susceptible than females.

3. All patients developing any respiratory complication within 30 days after operation are included in this report.

4. There were 218 operations performed on the breast, 114 on the vagina, and 604 tonsillectomies, without a respiratory complication.

5. In 201 fractures, only one patient developed a lung complication.

6. Thirty-nine patients (61.9 per cent) developed lung complications during the winter months.

7. In patients over 60 years of age, there were 19 deaths, 31 per cent.

8. In 31 patients, 49 per cent, there were heart or lung lesions prior to operation; 24 of these died, and 7 recovered.

9. Site of operation is a factor as shown by the following: 22 cases, 34.9 per cent, following upper abdominal operations; 9 cases, 14.28 per cent, following lower abdominal operations (6 hernias); 9 cases, 14.28 per cent, following cystotomies and prostatectomies; 5 cases, 7.93 per cent, following kidney operations; and 18 cases, 28.57 per cent, following operations in other locations (see Table V).

10. There were no cases of postoperative atelectasis diagnosed.

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CHANGES IN THE BILE DUCTS AND PARIETAL SACCULI FOLLOWING ABSENCE OF THE GALL BLADDER[1]

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KIERNAN, in 1833, in his thesis on the anatomy and physiology of the liver, gave the first comprehensive description of the intimate structure and functional activity of the liver and biliary system. He was the first to describe a few accessory gland-like structures found lying entirely within the walls of the ducts, communicating with the lumen by numerous minute orifices. In the pig, sheep, and horse they surrounded the wall completely, anastomosing within it and opening on the lumen from all sides. In man, however, they were arranged in two rows, on opposite sides of the ducts, with the orifices preserving the same relationship.

Theile, in 1844, by means of similar injections, observed that these structures consisted of branching clusters, terminating frequently in small cæcal diverticula. He considered them mucous glands comparable to the meibomian glands of the eye.

Beale, in 1856 and again in 1889, after extensive researches devoted to the subject, confirmed and extended the observations of Kiernan and Theile. He was the first to attach the term "parietal saccule" to the mucous glands of Kiernan and Theile, considering them ductal diverticula rather than mucous glands. He found that they occurred in the common and hepatic ducts, and in all of the intrahepatic branches as far distal as those measuring 1/125 of an inch (0.2 millimeter) in diameter. He found, also, that although anastomosis between parietal sacculi frequently occurred within the walls of the ducts, quite as often it took place outside them and within the parenchyma of the liver by means of irregular canals springing from the terminal cæcal diverticula. Beale thought these sacculi should be regarded as diverticula in which the bile may be retained temporarily while it becomes inspissated and probably undergoes other changes; in fact, he wished to regard them as supplementary little gall bladders appended to the ducts.

Holmes, in 1911, describing the mucous glands of the bile ducts and gall bladder, quoted Sappey's description of a system of accessory ducts connected with the bile ducts proper. He called these "vasa aberrantia" or "vaginal bile ducts" of the liver, although these were first noticed and named by Weber. Sappey thought these to be either of vestigial embryonal origin or that they appeared in the process of postnatal atrophy affecting a portion of the liver.

However, parietal sacculi and vasa aberrantia assume importance if considered in the light of work by Sweet, in 1924, when he reviewed the work of Beale and further contributed to the subject. If, according to the hypothesis of Beale, these structures were to be considered as accessory small gall bladders, then they should show some change, either functional or anatomic, following cholecystectomy. In animals without the gall bladder, such as the horse, Sweet found the sacculi to be large and numerous, whereas in animals with gall bladders they were flattened and inconspicuous. In dogs, after cholecystectomy, he noted an immediate rise in the value for cholesterol in the blood, which returned to normal after 40 days, and was considerably below normal in 74 days. Coincident with the fall in cholesterol of the blood, the parietal sacculi enlarged and became hypertrophied. He, therefore, believed that these structures took over the function of absorbing cholesterol from the bile, which Boyd has demonstrated in the normal gall bladder; in other words, that the parietal sacculi were actually subsidiary gall bladders.

Counseller, in 1928, substantiated the belief in the tortuosity and branching of the vasa aberrantia, and noted the curious fact that in the human being practically all the branches of the biliary tree and the vasa aberrantia arise from opposite sides of the duct along the lines of the parietal sacculi. He showed the dilating effects of obstruction in the biliary

[1] Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery. Work done in the Division of Experimental Surgery and Pathology.

tree and did not find the parietal sacculi or vasa aberrantia to be increased in size or number in cases in which the gall bladder was diseased or had been removed. In cases of choledocholithiasis and benign and malignant stricture, the vasa aberrantia were tremendously enlarged and sacculated, corresponding in degree to the amount of dilatation of the duct, while the parietal sacculi appeared to be absorbed by the wall of the dilating duct.

In the study reported here I wish to ascertain the effects of absence of the gall bladder, absent either in function, having been rendered so by disease although still present anatomically, or absent in fact, having been removed by surgical operation. The physiological properties of the gall bladder, so far as is known, have to do mainly with the concentration of the bile which enters it, and with regulation of pressure within the biliary system; in other words, it is a reservoir for bile, and concentrates and expresses bile into the duodenum for specific action on food (11, 13). Nothing definite is known at present as to its relation to metabolism of cholesterol. Filling of the gall bladder with bile is dependent on a functioning sphincter of Oddi, at the duodenal end of the common bile duct, as shown by Winkelstein and Aschner in 1926, when they inserted a small glass cannula into the papilla of Vater, thus keeping the sphincter patent, and it was found that all the bile flowed immediately into the duodenum, the gall bladder remaining completely collapsed.

Judd and Mann, and Mann later again, found that there was some dilatation of the extrahepatic part of the biliary tree after cholecystectomy, depending on an intact sphincter, and that this dilatation did not occur when the sphincter was destroyed. As to whether the biliary tree following loss of the gall bladder undergoes any changes which might have a tendency to compensate for this loss, or to enable it to take over its function, Judd has expressed the opinion that experimental evidence seems to show that this is not possible. He thought it more probable that when the gall bladder is missing, the function of concentrating the bile is eliminated, for the bile does not become concentrated in the common duct. Results of Graham-Cole tests on patients without a gall bladder seem to substantiate this belief, also (9).

Mann and Potter noted an increase in the pressure in the common bile duct immediately after cholecystectomy.

Sutton, in 1930, in a microscopic study of the injected bile ducts of the cholecystectomized dog, came to the conclusion that parietal sacculi enlarge, and their epithelium, as well as the epithelium of the bile ducts, undergoes changes so that it comes to resemble the epithelium of the normal gall bladder.

METHOD

The work undertaken in this study was done partly with material obtained at necropsy, from unembalmed subjects dead less than 3 hours. Studies were made of both injected and uninjected specimens, exemplifying the normal structure in the human being; the youngest subject was a fetus of 5 months and other subjects were in old age. Livers of the monkey, dog, pig, rabbit, and rat also were studied. In the injected specimens the method employed by Sutton was tried, but it was found that essentially better results could be obtained by omitting the injection of gelatin, and perfusing the organ with formalin while the specimen was fresh, thus fixing it quickly. Injection into the bile ducts of any gelatin-like substance, under pressure of 100 to 180 millimeters of mercury, distends the walls of the ducts, and this has a tendency to efface all but the larger folds of epithelium lining the tracts. This very fact defeats the object of the study; that is, to find if possible the true reason for the formation of certain foldings or villous processes in the epithelium of the bile ducts. The cause of this evident change can be found and properly interpreted only by close study of the sacculi and their smaller, cæcal diverticula, and such a study can best be made by examining many slides of serially sectioned ducts, both intrahepatic and extrahepatic. Otherwise, if a section is taken here, and another there, and studied as representing the condition existing throughout the duct, many faulty opinions and erroneous ideas are sure to arise. After the preparation of many specimens by the injection method and their microscopic study by serial sections, it was found

Fig. 1. Bile ducts with anastomosing vasa aberrantia and parietal sacculi (Sappey).

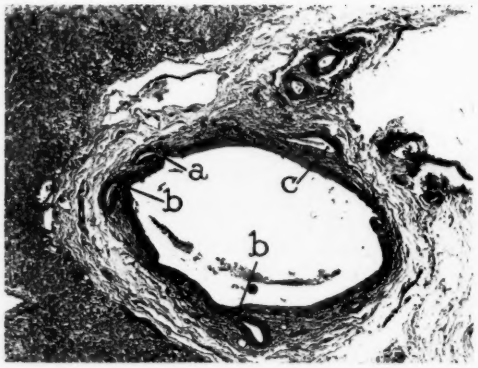


Fig. 2. Normal intrahepatic bile duct of a dog.

that the state of affairs in the natural, undistorted structures could best be learned by practically instantaneous fixation of the tissue by perfusion with formalin, and no subsequent injection of the ducts.

The experimental side of the problem consisted in performing cholecystectomy on a series of normal dogs. The animals were then killed at periods of 30, 60, and 90 days after operation, and the livers perfused with formalin. Also, the common ducts of rats, which possess no gall bladder, were ligated, and the rats killed 8 days after operation; others were allowed to die, and death occurred in about 18 days.

OBSERVATIONS

Thirty days after cholecystectomy, definite changes were noted in all the extrahepatic bile ducts of the dog. These changes were in direct proportion to the dilatation of the ducts. The intrahepatic ducts, situated in the liver proper, and supported on all sides by this non-distensible tissue, were conspicuous in their failure to show the changes which were so evident in their continuations outside the hepatic substance.

A diagrammatic scheme of the extrahepatic bile duct, together with the parietal sacculi and the system of vasa aberrantia, or vaginal bile ducts, is best described by Sappey (Fig. 1).

The normal intrahepatic bile duct of the dog is lined with tall columnar epithelium, as is the gall bladder (Fig. 2). Around the lumen of the duct, parietal sacculi, cut at varying levels, are shown. Of these, one, *a*, is cut exactly through the orifice by which it opens into the duct, and the others, *b* and *c*, not quite through the orifices. On the upper side of the duct is a saccule, *c*, cut at a level giving an appearance as though it might have no direct connection with the duct. Around the extrahepatic bile ducts, as well as in their walls, particularly the wall of the common bile duct, these structures are much more numerous, anastomosing with each other, presenting small cæcal diverticula, and some having aberrant bile ducts leading from them.

Marked changes had taken place in the common hepatic bile duct of a dog within 30 days following cholecystectomy. Dilatation of the sacculi was apparent, and the so called folding or villus-like projections had made their appearance (Fig. 3). At *a*, a dilated saccule was sectioned just through the margin of its opening into the main duct. In the next serial section the level of the cut was directly through the opening into the saccule, so that two villi, similar to that at *c*, were produced. At the point *d* an adjacent saccule was sectioned close to its ostium. *b* and *e* appear in the figure as two independent sacculi, and yet serial sections of them showed clearly that *e* emptied into *b* and that *b* opened directly into the lumen of the duct. Sacculi *e* and *b* were continuous with each other and with the main duct through the ostium of saccule *b*. The irregularities appearing within the sacculi are

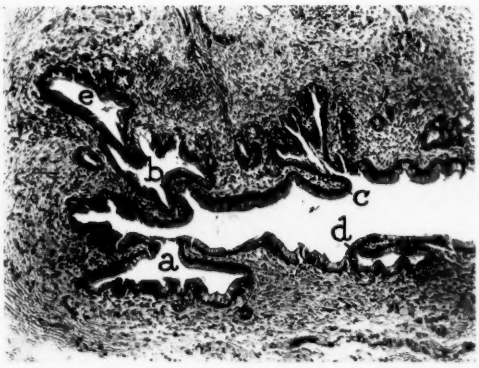
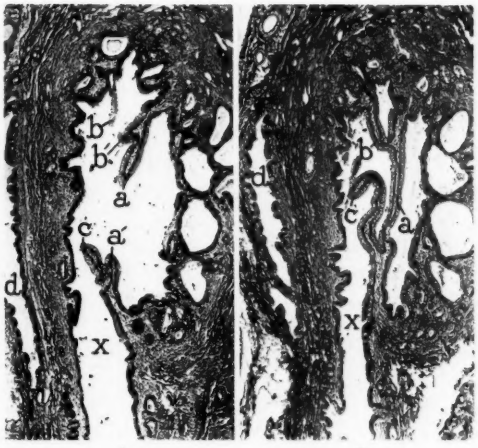


Fig. 3. Common hepatic duct from dog 30 days after cholecystectomy.

smaller cæcal pouches cut through their similarly dilated openings. These cæcal diverticula are in evidence around the sacculi and duct, appearing as gland-like structures, but in reality they are sacculi cut at levels other than through their orifices.

At 60 days following operation, numerous sacculi surrounding the hepatic duct gave evidence of dilatation, and so-called villous processes projected into its lumen (Fig. 4, A and B). When serial sections are followed however, it appears that fold *a* and *a'* and fold *c* are not villi but are merely the walls of enormously distended sacculi; for these folds, in adjacent sections (Fig. 4, B), meet, fuse, and form the definitely isolated saccules. Furthermore, comparable conditions were encountered in the aberrant bile ducts, as shown in the left side of each figure. It is not difficult to see how a single section, taken as a criterion by which to judge the true formation in the ducts, would be entirely misleading. It is also easy to see how distention of these structures with a semisolid substance under high pressure would have a tendency to distort the real picture.

A section of the common bile duct of a dog, operated on 90 days before, illustrates the extent to which this system of sacculi may develop (Fig. 5 A). As one traces the biliary tract upward from the duodenum, these become decreasingly numerous as the periphery of the liver is reached. The structures which appear as folds or villi in the section are but



A B

Fig. 4. A, Hepatic duct of a dog 60 days after cholecystectomy; B, serial in sequence from same duct as A.

cross sections of the openings of the dilated sacculi and their adjoining cæcal diverticula.

A section of the hepatic duct of a rat, the bile duct of which had been ligated 8 days,

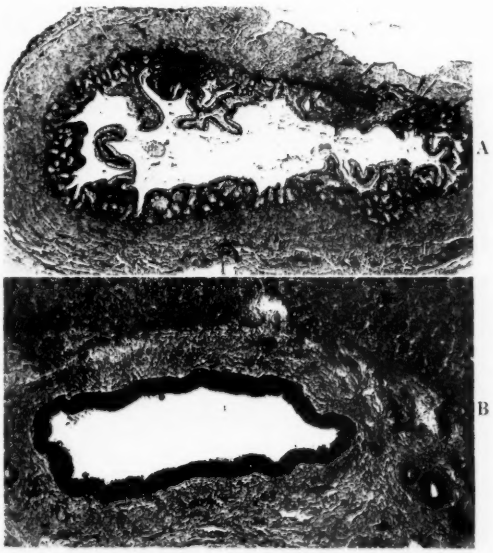


Fig. 5. A, Common duct near the duodenum of a dog cholecystectomized 90 days; B, intrahepatic bile duct of dog cholecystectomized 90 days. Scharlach R stain for lipoid.

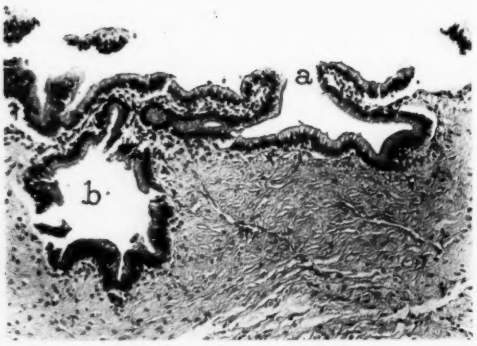


Fig. 6. Portion of cross section of wall of hepatic duct of human being 4 days after cholecystectomy.

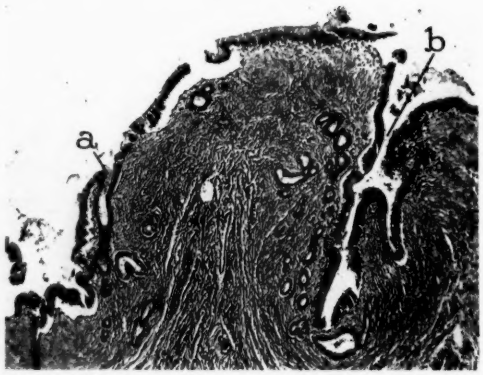


Fig. 7. Another portion of wall of same duct as shown in Figure 6.

presents essentially identical conditions. The rat possesses no gall bladder, but, as shown by Higgins, has a secondary plexus of bile ducts surrounding the branches of the portal vein. In the common duct of a rat, ligated 18 days, the duct was dilated from a diameter of 1 to 2 millimeters to one of 2.5 centimeters. The lining epithelium in this case was flattened greatly, and all sacculi had disappeared.

In a dog subjected to cholecystectomy 90 days before, the epithelium of all hepatic ducts took a heavy, brilliant red when stained with scharlach R for lipoid (Fig. 5 B). This lipoid has the double refractility of cholesterol when examined by Nicol prisms, but on fractional analysis is shown to contain of a total of 22 per cent fat, only 0.6 per cent cholesterol, or in a proportion of 1 to 40. This increased deposit of lipoid in the biliary epithelium seemed to be constant in all the dogs used in this work. In normal dogs this did not seem to be the case; and in a dog operated on one year before, the condition was much less marked. However, no attention was paid to how recently the dogs had been fed, although none of them had been fasted. This liposis was present in the epithelium of all the hepatic ducts, sacculi, and aberrant ducts, even to the smallest biliary tubules, as shown in Figure 5 B. Gall bladders of human beings, the site of cholesterosis, differed from those of dogs in that the greatest amount of lipoid appeared to be in the subepithelial tissue, whereas in the bile ducts of these dogs which had been subjected to operation it was confined almost entirely to the epithelium. The term "cholesterosis" however, seems a misnomer for the condition; "liposis" is more descriptive of the true state of affairs.

A number of observations have been made on bile ducts of human beings taken at necropsy within a relatively short time after death, wherein various pathological conditions had induced changes in the biliary system. Of these, a group of cases was observed in which operative cholecystectomy had been performed at some time, the most recent one 4 days before, and the oldest one, 9 years and 4 months before. Other patients had no operative cholecystectomy, but had experienced interference with the reservoir capacity of the gall bladder, owing to the presence of stones, or of disease without stones, amounting in some instances to what one might term "complete loss of function." Studies were made of three cases of malignant obstruction of the bile ducts in which the gall bladder was apparently in good condition.

In hepatic ducts of a patient who had undergone cholecystectomy 4 days previous to examination, conditions were encountered resembling markedly those described for the dog (Figs. 6 and 7). Definite folds are shown, but these are only the walls of a dilated saccule cut through its orifice at *a*. Just to the left, at *b* (Fig. 6), is either a separate saccule or a part of the one marked *a* so sectioned as not to show its ostium in the duct. In Figure 7, at *a*,

is a similar arrangement, and at *b*, an aberrant duct or deep saccule with cæcal diverticula extending from its lumen, giving the appearance of folds between them. In this case, 4 days after operation, it is manifestly improbable that these folds had arisen as a result of hyperplasia in consequence of the recent cholecystectomy. It is more likely that they were the result of the lost reservoir capacity of the diseased gall bladder which had been removed.

It is impossible, in this brief presentation, to consider all cases in which I have examined pathological changes in the biliary structures; consequently, only one of the cases in which cholecystectomy was performed has been described. However, similar findings were present in all cases studied at necropsy, and the results were practically constant in those cases in which marked increases in intraductal pressure were manifest. Infection has to be taken into consideration, but in an affirmative rather than in a negative way. A dog's cystic duct, the site of severe infection, and with muco-purulent material practically obstructing it, presents the same appearance of folds from dilated sacculi as are found in other forms of obstruction or increased pressure within the ducts.

A diagnostic scheme perhaps most adequately illustrates the sequence of events in dilatation of biliary ducts from intraductal pressure (Fig. 8). Part I of Figure 8 represents a primary bile duct *C* with parietal sacculi *B* and a small cæcal pouch *A*, the latter not seeming to communicate with *B*. Under the influence of increased intraductal pressure, from whatever cause, such as obstruction from calculi, from carcinoma of the head of the pancreas, or from loss of the gall bladder either by operation or by disease, changes are induced such as are represented in part *II*. This shows the communication between *A* and *B*. The orifice of *B* opening into duct *C* is widening, and the section makes the two opposite lips of the ostium of the saccule appear as two folds projecting into the lumen of duct *C*. In part *III* the condition is a little more marked, even the small orifice of *A* appearing as though bounded by two minute folds. The next part, *IV*, of the drawing is simply a step further in the process, and is probably as far as the dilatation would ever go in uncomplicated cholecystectomy. If the obstruction is caused by carcinoma of the ducts, or of the head of the pancreas, or by impacted calculi completely blocking the common bile duct, the process passes rather rapidly through the first four stages into a condition represented in part *V*. The last stage represents the condition in a severe dilatation from obstruction, and can be experimentally produced in a rat by ligation of the common bile duct. This is the stage in which dilatation has progressed as far as possible, and the steadily increasing pressure had flattened the once tall columnar epithelium until it is low cuboidal in type. This last appearance is what would be the inevitable and constant result if the sacculi and vasa aberrantia were not present to distort the picture, as revealed in the figures of bile ducts from cholecystectomized dogs.

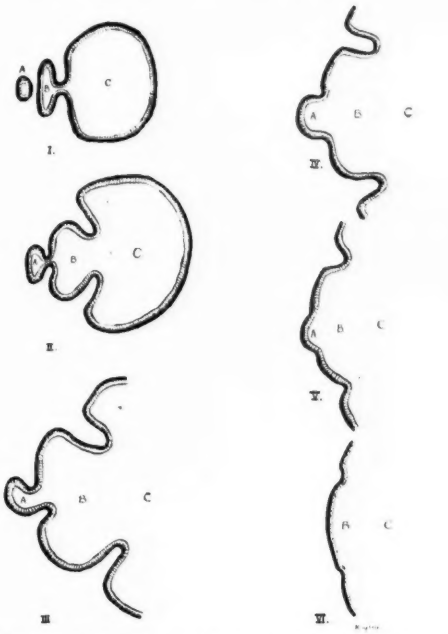


Fig. 8. Sequence of events in production of dilatation of biliary duct (Humphrey).

DEDUCTIONS

The questions to which I have endeavored to find answers resolve into the following: Are

there any structures along the bile ducts which tend to assume the functions of the gall bladder in its absence? Do the parietal sacculi and vasa aberrantia, in the absence of the gall bladder, undergo hypertrophy and carry on inspissation of bile? Hitherto, changes have been noted in the lining epithelium of the extrahepatic bile ducts, interpreted as a reaction on the part of those structures to enable them to assume the anatomical appearance of the epithelium of the gall bladder, and, along with this change, to assume also its physiological functions. These questions have been answered rather affirmatively by some workers, using dogs in their experiments, but no study has been made, so far as I am aware, of such changes in man.

The changes which have been noted following cholecystectomy in dogs should of necessity appear simultaneously in all the bile ducts, both intrahepatic and extrahepatic. As shown in the microscopic sections of bile ducts of cholecystectomized dogs killed at periods of 30, 60, and 90 days after operation, these changes are constantly noted in the extrahepatic ducts, but never in the intrahepatic ducts, that is, those completely surrounded by hepatic parenchyma, if cholecystectomy was not accompanied by obstruction. In one dog, which had undergone cholecystectomy 1 year before, but with added obstruction and infection severe enough to result in practically complete atrophy of one lobe of the liver, these changes were noted in the intrahepatic ducts also, but only in those in which the sections passed through parietal sacculi or vasa aberrantia. Therefore, the extrahepatic ducts, which are easily distensible, are the situations most propitious for the development of these changes. The alternating dilatation from distention with bile held back by a functioning sphincter of Oddi, and the subsequent recoil by the elastic tissue in the wall of the duct when the sphincteric mechanism is forced to let go, is the method by which these changes are wrought.

I have never been able to find mitosis, or other evidence of hyperplasia, and the apparent increase in the height of the epithelial cells lining the ducts and sacculi, is, I believe, due to the recoil of the elastic tissue in the wall of the duct. In the extrahepatic bile ducts of the rat, which has no gall bladder, similar conditions were noted on the increase of tension due to ligation of the common bile duct. When the duct of the rat was ligated for 18 days, conditions corresponding to those seen in malignant obstruction in man were encountered.

In man these changes were likewise found following cholecystectomy, and were more noticeable if obstruction was superimposed. They are also found if obstruction is the only pathological condition, and if the gall bladder is present and functioning. It would appear that dilatation resulting from increased intraductal tension is the more probable theory, which can safely and accurately account for the changes in the biliary ductal system. Following cholecystectomy, both clinically and experimentally, there is gross dilatation of the extrahepatic ducts, as well as a slight increase microscopically in the amount of elastic tissue in the walls of the ducts.

In most textbooks on histology wherein the biliary ducts are described, there is usually reference to and illustration of the "glands of the ducts." From the serial sections of the common bile duct where it enters the duodenal wall, on up through the hepatic and intrahepatic bile ducts in man and dog and rat, the only structures present in the walls of the ducts which might be interpreted as mucous glands, are the parietal sacculi, with their cæcal diverticula or vasa aberrantia. These structures, when sectioned at levels not showing their communication with the lumen of the main duct, resemble glandular elements, but if studied and traced through numerous serial sections, they will be recognized. They do not resemble true glands, they dilate just as do the bile ducts, from obstruction, and the epithelium exhibits the same fat-absorptive properties as that of the epithelium of the bile ducts and gall bladder. These facts, taken in consideration with the apparent increase of the structures in cases of portal cirrhosis, seem to demonstrate rather satisfactorily their ductal properties and relationship, and that there are no such structures as true mucous glands of the bile ducts. True, their lining epithelium secretes mucus, and so does the epithelium of the ducts and gall bladder, but as shown by

sections stained with mucicarmine, they never contain mucus in any greater degree or amount than the cells lining the main ducts and gall bladder.

From the standpoint of clinical and practical application, the findings in this study resolve themselves into those changes contingent on increase in pressure in the biliary ductal system, from any cause whatsoever, the extent of these changes being in direct proportion to the degree of the obstruction. The increased tension following cholecystectomy is one which progresses until equilibrium is established between the dilating ability of the elastic tissue in the wall of the ducts and the point at which the pressure is such as to overcome the sphincteric mechanism at the duodenal end of the common bile duct, at which time the bile is expelled into the intestine. In other words, if this sphincteric mechanism, which is necessary to fill the gall bladder, were not present, and the bile had a free, unobstructed pathway into the intestine, there would be no dilatation of the biliary ductal system and consequently no distention of the sacculi.

SUMMARY AND CONCLUSIONS

1. The villus-like folds found in the bile ducts following cholecystectomy are dependent on the presence of sacculi, or vasa aberrantia, in the walls of the ducts.

2. These villi are not hypertrophied folds of epithelium, but the walls or lips of the dilated sacculi, or vasa aberrantia, sectioned through the orifice by which they communicate with the main duct.

3. These folds do not appear in the intrahepatic ducts following cholecystectomy as they do in the extrahepatic ducts which can dilate easily; consequently, there seems to be no evidence that the ducts and sacculi take over the functions of the lost gall bladder. If the latter were the case these changes should be noted in the entire system of ducts simultaneously.

4. Obstruction of the bile ducts, with a normally functioning gall bladder present, produces these same changes, and if superimposed on an operative or spontaneous cholecystectomy, it accentuates them. Severe obstruction will produce very bizarre appearances of the bile ducts, even those supported by hepatic parenchyma or dense connective tissue.

5. Identical changes can be produced by ligation of the common bile duct of the rat, which does not possess a gall bladder, but does possess a system of sacculi and secondary bile ducts.

6. There does not seem to be any epithelial activity, as regards hypertrophy or hyperplasia, in response to any physiological demand.

7. The changes are brought about mechanically by intraductal pressure from obstruction, or from loss of the reservoir and expansile properties of the gall bladder.

8. Obstruction by carcinoma or by calculi impacted in the common bile duct, and allowed to remain, produces effacement of the sacculi, dilatation of the ducts and vasa aberrantia, and finally flattening of the epithelium from columnar to a low cuboidal type.

9. There do not seem to be any true mucous glands in the walls of the common bile duct, from the point of entrance into the duodenal wall, up through the hepatic and intrahepatic ducts; the only structures present are parietal sacculi and vasa aberrantia, lined with the same type of epithelium as the ducts, and having the same functions.

10. Appended to the biliary ducts are parietal sacculi and vasa aberrantia. These latter may take origin from a saccule or directly from the duct itself. They may or may not anastomose with another similar structure over rather long distances.

11. A parietal saccule may be a simple evagination, or may have secondary cæcal diverticula arising from it and communicating with its lumen.

12. This phase of intraductal pressure may play an important part in infections of the biliary tract, and in the disturbance of metabolic functions of the liver if the organ is already badly diseased.

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MAGGOTS AND THEIR USE IN THE TREATMENT OF CHRONIC OSTEOMYELITIS[1]

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THE gift to observe accurately is given to few, but the gift to interpret observations properly and to apply them effectively in the solution of confronting problems is given to only an occasional student. Ambroise Paré (1509–1590) was the first, so far as is known, to note the beneficial effects of maggots in suppurative wounds. D. Hieronymus Fabricius (1634) also noted the effect of maggots on wounds. Zachmann (1704) made the first attempt to explain the origin of maggots in wounds. D. J. Larrey (1766–1842), a famous military surgeon of the Napoleonic armies, observed maggots in the wounded, and J. G. Millingen made a similar observation in 1809. More recently, in the United States, Shafer, Crile, and Martin spoke of this disgusting infestation and noted its beneficial effects, while W. W. Keen called attention to its occurrence during the Civil War. These are apparently the only notes in the medical literature concerning maggots in suppurative wounds. In modern hospital practice, such infestations occur from time to time, and are looked upon with disgust and shame. Many surgeons have seen maggot infested wounds, but few have realized their possibilities.

J. F. Zacharias, of Cumberland, Maryland, a surgeon in the Confederate Army, was apparently the first to utilize maggots successfully in the treatment of suppurations. His experiences, however, seem to have been forgotten, until they were duplicated by the late William S. Baer. To our knowledge, Zacharias and Baer are the only observers who have realized the significance and possibilities of the use of maggots and are the only ones who have made a practical application of this agent in the treatment of suppurative wounds, a method new in principle, for here neither physical nor chemical antisepsis in the commonly known forms is attempted, but instead, there is introduced what Baer calls a viable antiseptic.

Following a battle in 1917, during the World War, Baer observed two soldiers who had sustained compound fractures of the femur, and large flesh wounds of the abdomen and scrotum. They had been lost on the battlefield for 7 days, without water, food, or medical attention. To his great surprise, their condition, save for that incidental to hunger and thirst, was remarkably good. Closer inspection revealed that their wounds, which presented pink granulations, practically no bare bone, and only a few streptococci and staphylococci, were filled with thousands of maggots.

For ten years, Dr. Baer thought of this experience, and finally in 1927, he put his observations to practical use in civil surgery. The story of Baer's struggles with, and the surmounting of the problems which arose incidental to obtaining a continuous supply of sterile maggots, and their application to surgical problems, is stranger than fiction. His experiments to show that the maggots can successfully contend with any infecting organism, save tetanus, are masterful. The meticulous technique he developed for the culture of the fly larvæ and their clinical application has been recently published, posthumously, in great detail, and will therefore not be gone into at this time.

We had the good fortune to visit Dr. Baer at his Clinic in the winter of 1930, and were so impressed with his results that on the basis of our report, the Medical Board of the Hospital for Joint Diseases set aside twelve beds and all the necessary laboratory facilities to investigate this treatment. Although our investigation has not been carried on for a sufficient length of time to enable us to render a final report, we feel justified in making known our experiences and observations.

[1]Read before the Orthopedic Section, New York Academy of Medicine, December 18, 1931.

Fig. 1. Incubator partitioned horizontally by perforated sheets of galvanized iron. Under the lowermost compartment is a section in which electric space heaters are installed to maintain the temperature at 75 to 80 degrees F. On the back wall of the middle compartment is the thermostat. In the roof of the incubator are vents to which a motor-driven blower is to be connected by pipes for ventilation. Pans of water are placed on the top of the electric space heaters to maintain the humidity at 50 per cent.

TECHNIQUE OF THE CULTURE OF MAGGOTS

The first problem was to culture the maggot of the blowfly. Notwithstanding Baer's detailed technique, a great many difficulties were encountered, for slight variations in temperature, humidity, ventilation, and feeding resulted in decimation of the flies; and the sterilization of the eggs was a problem in itself. As a result of our studies, we have evolved our own technique, which is based on that of Baer's and its modification by Edward F. Roberts. [1]

We utilize for the breeding of flies a wooden incubator (Fig. 1) with glass sides and doors, measuring 24 inches wide, 28 inches deep, by 75 inches high. It is divided horizontally into three sections by perforated sheets of galvanized iron. Under the lowermost section there is a compartment in which there are installed thermostatically controlled electric space heaters, which maintain a temperature of 75 to 80 degrees F. Pans of water are placed on the top of the electric heater to insure a humidity of about 50 per cent. Ventilation is maintained by a motor driven blower connected by several vents to the top of the incubator. The blower is so arranged that it draws out of the incubator air which enters by way of two holes, one on each side of the base, and leaves through the vents in the top. By plugging one or more of these vents the degree of ventilation may be controlled. Electric bulbs on the outside of the incubator supply the necessary light.

After several months' trial, we abandoned the use of the small cages devised by Dr. Baer for housing flies. These were replaced by larger cages (Fig. 2) consisting of wooden frames, 20 by 25 by 18 inches, covered on five sides with fine wire mesh. The front of the cage is covered with scrim fitted with a sleeve to enable convenient entry. The larger cages are very satisfactory as a time-saving device in the feeding and handling of the flies. Furthermore, the life of the flies and their fecundity is increased.

Our experience with these cages confirms the observations of Roubaud, who has shown that in larger cages, longevity is increased and egg lays are more numerous. He has noticed that in small cages wings break readily, thus interfering with flight, and resulting in lessening of metabolism. It also appears that the activity incidental to flight aids in the abdominal contractions necessary for the deposition of eggs.

The flies are fed on a mixture of strained honey and water in the proportion of 6 teaspoonfuls of honey to 300 cubic centimeters of tap water. To this is added about one-fifth of a cake of yeast. Medium thick pads of gauze are thoroughly soaked with this mixture and placed in petri dishes in the bottom of the cages. This mixture is renewed about twice a week. On the other days, sufficient water is added to the petri dishes to

[1] Dr. Roberts who is in charge of the culturing of maggots at the Lederle Laboratories at Pearl River, New York, has been very kind in co-operating with us, and we gratefully acknowledge our appreciation of his help.

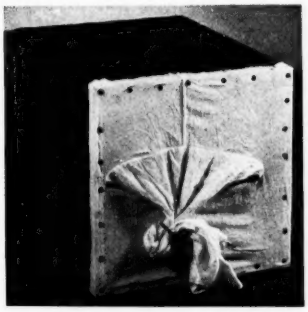

Fig. 2. Fly cage covered on five sides with fine wire mesh while the front is covered with scrim fitted with a sleeve for convenient entry. The size of the cage is such as to fill an entire compartment of the incubator.

Fig. 3. Apparatus for sterilization of eggs, consisting of a Gooch crucible lined with a piece of muslin covering the perforated plate and extending half way up the sides, fitted into a filter tube which is suspended by a triangle over a tripod. The lower end of the filter tube is fitted with rubber tubing which can be clamped by a pinch-cock. A waste beaker is placed for the filtrate.

keep these pads well moistened. Besides the honey, yeast, and water mixture, thin folded slices of beef about 2 inches square are placed in the cages. The beef serves as an essential source of food, for Roubaud has shown experimentally that in the absence of nitrogenous substances, the production of eggs does not occur and the flies remain sterile, although their lives are not shortened. Furthermore, he has shown that chemotropism plays a part in egg-laying for which the stimulus is best supplied by meat. These foods are placed in the cages as soon as the flies begin to hatch.

After about 7 to 10 days, egg laying begins. The eggs are deposited in the folds and on the dark under sides of the meat. The meat with the eggs may then be stored in the ice box at 40 degrees F. for as long as 24 hours, or sterilization may be carried out at once. At any rate, one should wait several hours before sterilizing the eggs, for the hatches from eggs that are sterilized immediately after laying are not as large as from those in which there has been a delay of several hours. The eggs are carefully picked from the meat with a wooden applicator, placed in a small amount of cold water, and the clumps of eggs are gently broken up.

The apparatus (Fig. 3) for the sterilization and washing of the eggs is prepared as follows: Gooch crucibles are lined with pieces of muslin covering the perforated plates and extending half way up the sides. The crucibles are covered, wrapped, and sterilized in hot air at 160 degrees C. for 1 hour. For the sterilization process, the crucibles are fitted into filter tubes which are always kept in 5 per cent phenol solution. These are held suspended by means of triangles over tripods with beakers underneath to catch the filtrate. The narrow lower ends of the filter tubes fit into pieces of rubber tubing which can be clamped by means of pinch-cocks. When this apparatus has been set up, about 1,000 eggs are poured into each Gooch crucible. The water is allowed to pass through, and the rubber tube is closed by means of the pinch-cock. The crucible is then completely filled with the sterilizing fluid, its surface is flamed, and the crucible is covered. The eggs are sterilized for one-half hour in this solution, which contains 1:4,000 bichloride of mercury, 25 per cent alcohol, and 0.3 per cent hydrochloric acid. At the end of the allotted time, the sterilizing solution is drained into a waste beaker and the eggs are washed with about 5 ounces of sterile water. The muslin with the eggs on its surface is then transferred with sterile forceps from the crucible to an Erlenmeyer flask containing sterile food.

The sterile food consists of 10 per cent Bacto-liver and 1.5 per cent of agar in distilled water. Two and a half cubic centimeters are measured into each Erlenmeyer flask, which is plugged with a muslin-covered cotton

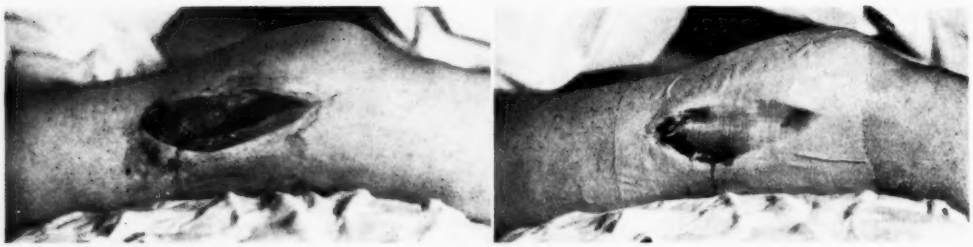

Fig. 4. Left, wound before the application of the cage; right, muslin cage held in place by liquid adhesive.

plug, and the flask and contents are sterilized in an autoclave for 15 to 20 minutes at 15 pounds pressure. The medium is smooth and homogeneous and the 2.5 cubic centimeters are sufficient to feed the maggots for 3 days. Out of each batch of flasks prepared, one is controlled for sterility, while the rest are stored in the ice box, where they will keep for a month.

After inserting the eggs into the Erlenmeyer flask, they are incubated in the dark at 75 to 80 degrees F. Hatching begins in about 8 to 24 hours. The day after the eggs are sterilized and hatched, control cultures are made in both Bacto-brain-heart infusion (aerobic) and Bacto-egg-meat medium (anaerobic). The transplants for these cultures consist of a small piece of medium with one or two maggots. The cultures are incubated for 48 hours. Thus, at the end of 48 to 72 hours from hatching, the sterility of the maggots is assured and they are ready for use. The larvæ may be used immediately, or if necessary, they may be stored in the ice box at 40 degrees F. for several days. This period of storage does not shorten their period of usefulness, for they become inactive and require no food.

In addition to raising maggots for treatment purposes, it is necessary to grow a sufficient number of larvæ to maintain a breeding stock of flies. Our experience has been that if 25 to 100 eggs are left on the meat from which eggs have been removed for sterilization purposes, and are allowed to hatch, there will be enough maggots to maintain the supply of flies. The pieces of meat with the remaining eggs are therefore put into wide-mouthed 2 ounce bottles, covered with muslin, and allowed to hatch. After 5 days, the covers are removed from the bottles, and the latter are then placed into muslin covered large beakers, in the bottom of which there is about 1½ inches of ground cork. In about 7 days, when the maggots are ready to pupate, they crawl over the sides of the bottles, dig their way into the cork, and pupate. The pupating beakers should be kept in a dark incubator at 75 to 80 degrees F. When all the larvæ have left the breeding bottles, the bottles are removed. In 5 to 8 days, when the flies are ready to emerge from their pupæ cases, the beakers are placed in the breeding cages.

It will be seen from the technique described that a great deal of labor and time is saved over the previously described methods of breeding.

In general, the breeding of maggots, simple as it seems, is confronted with many failures and disappointments. These are due to an insufficient knowledge of the life history, physiology, and pathology of the fly. According to Wollman, the difficulties in the culture of flies are due to injuries and intercurrent infections. Under the heading of injuries, wing breakage is most important. Its effects have already been discussed in relation to the construction of cages. The chief intercurrent infection is that due to the parasite known as Empusa muscæ. It appears to be very common among flies. Its action, however, is slow and the longevity and fecundity of the host is not affected to any great extent under favorable conditions. Sudden climatic changes, however, especially a sudden lowering of the temperature or an increase of humidity will hasten its pathological activity and cause very extensive mortalities (Roubaud). Fortunately, our stock has apparently not been

Fig. 5.

Fig. 5. Case 1. An extensive osteomyelitic involvement of the right tibia and fibula and left tibia.

Fig. 6. Fig. 7. Fig. 8.

Fig. 6. Case 1. The right tibia 7 months, the right fibula 5½ months, and the left tibia 2½ months after the operation and the beginning of maggot therapy. Note the homogeneous bone repair.

Fig. 7. Case 1. An extensive osteomyelitic process of the right humerus.

Fig. 8. Case 1. The humerus 3½ months after operation and the beginning of maggot therapy. Note the absence of areas of sclerosis and rarefaction seen in other methods of treatment.

affected by this parasite. Furthermore, the physiological variations are very great (Roubaud). Even under constant conditions of temperature and alimentation, the succession of egg lays is irregular in numbers and periods. The latter may vary in intervals from 3 days to several weeks. It is, therefore, not surprising that even with the best of care the supply of maggots will be interrupted from time to time especially during the winter and humid seasons.

To overcome these difficulties, it is advisable to accumulate a large quantity of pupæ for such contingencies. The Bureau of Entomology of the United States Department of Agriculture has proved experimentally that the pre-pupa maggot, that is, the 5 to 7 day old maggot, and the pupa can be kept inactive at 40 degrees F. for several months at least; possibly longer. We have fortified ourselves against such contingencies by accumulating a large number of pupæ which are kept in the ice-box. This is especially necessary in large cities where the blowfly is hard to find.

The Phormia regina, Sucilia sericata, and the Lucilia caesear are the species of flies which were found satisfactory by Baer. This was confirmed by our experience. Care must be taken, however, to guard against unknown species. We had one unfortunate experience resulting from the accidental introduction of an unknown species. In an effort to increase our stock of flies, meat was exposed in a local butcher shop in which a great number of green and blue bottle flies were seen. For the same reason, maggots were taken from a fac-

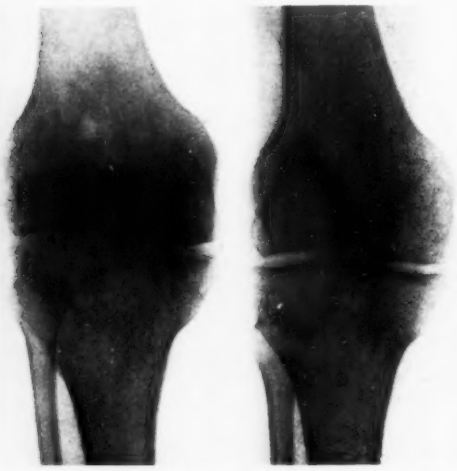

Fig. 9, left. Case 2. An area of rarefaction surrounded by an area of irregular sclerosis in the supracondylar and intercondylar regions.

Fig. 10. Case 2. Four months after operation and maggot therapy showing homogeneous bone repair. The area of saucerization is still discernible.

Fig. 11, left. Case 3. A chronic sclerosing osteomyelitis of the femur with irregular bone formation.

Fig. 12. Case 3. Two months after the onset of treatment. Note the reformation of normal bony structure without the irregularities of calcification present previously.

tory in which chicken feathers were used for commercial purposes. The resulting maggots and pupæ were indistinguishable from those of the known species with which they were inadvertently mixed. When the next batches of sterile maggots were introduced into osteomyelitic wounds, we were shocked to find deleterious effects, for these maggots had bored large cavities in the healthy granulations, and had actually increased the size of the wounds, which were angry looking and caused considerable pain. Needless to say, the entire batch of flies, maggots, and pupæ was discarded. A number of these flies was submitted to a competent entomologist for classification. Unfortunately, he was unable to recognize the offending fly because only specimens of the male species had been submitted, while his key apparently depended upon the female. The United States Department of Agriculture in its *Farmers' Bulletin* No. 857 describes the screw worm maggot and in a personal communication warned against its use.

CLINICAL PHASE OF THE MAGGOT TREATMENT

The clinical phase of this treatment vies with its laboratory counterpart in that its problems are intricate and time consuming. We must emphasize, as did Dr. Baer, that this is a surgical problem which cannot be passed over lightly. The preparation of the part consists of shaving and cleansing with soap and water. No chemical disinfectants are used. The operative procedure must be a complete and thorough saucerization. All devitalized bone must be removed for reasons that will be discussed later. Because of the extensiveness of the operation, it should be done whenever possible under tourniquet control. It is our practice to line the saucerized wound liberally with vaseline gauze, pack its center with plain gauze, and subsequently apply a compression bandage of sheet wadding, flannel bandage, and adhesive plaster. Plaster-of-Paris bandage support is used when fracture of the part is feared. It is also used to eliminate pain and discomfort when the operative wound is extensive and in close proximity to a joint. After 3 or 4 days, the packing is removed—a procedure which is comparatively painless and bloodless because

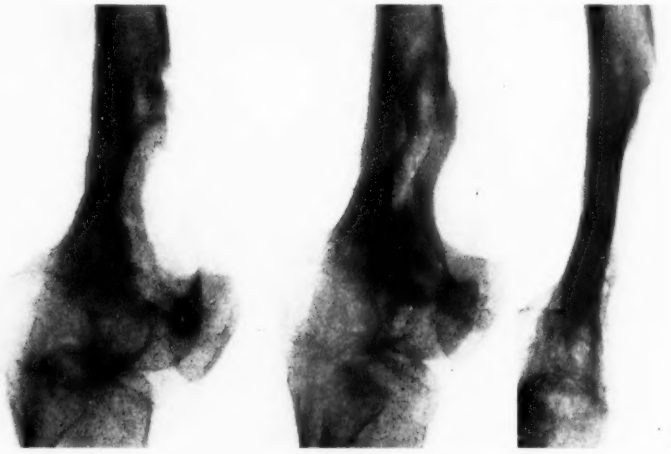

Fig. 13. Fig. 14. Fig. 15.

Fig. 13. Case 4. Roentgenogram taken immediately after first operation.
Fig. 14. Case 4. Three months later, showing smooth and evenly calcified bony repair of upper half of saucerized area while the lower half shows sequestra and irregularities in calcification.
Fig. 15. Case 4. Five months after the second operation and further maggot therapy. Note the smooth bony repair.

of the vaseline gauze. About 1,000 maggots are then introduced into the wound and a cage is applied.

Baer's method of transferring the maggots to the wound involved the removal of the maggots from their food medium, their suspension in saline solution, the passing of this through a sterile spoon with a perforated bottom, and the emptying of this spoon containing the maggots into the wound. This is a rather fussy procedure resulting in the loss of very small maggots which may pass through the holes of the spoon and the crushing of others in the process of handling. We have simplified this by adding saline solution to the Erlenmeyer flask containing the maggots and passing this suspension through a piece of fine meshed sterile muslin. The muslin containing the larvæ is then placed into the depth of the wound. This method has proved to be much simpler, faster, and less wasteful.

It was originally our practice to use cages of the type devised by Dr. Baer. Their preparation was tedious and time consuming. Furthermore, they were irritating to the skin about the wound, clumsy in application, and on occasions inefficient in that maggots escaped from time to time. We, therefore, looked about for a simpler and less time consuming method. It occurred to us to paint the edges of the wound with liquid adhesive and to spread over the skin and wound a piece of sterilized fine meshed muslin. This simple method (Fig. 4) proved very effective, and has been used exclusively ever since.

Since the life of the maggot is only 7 days, 2 of which elapse in the process of growing to a sufficient size and culturing for bacteria, only 5 days are left for their utilization in the actual treatment of wounds. It is, therefore, necessary to change these dressings every 5 days at the utmost until the wound is completely filled with granulations.

Baer advised thorough washing of the wound with saline at each of these dressings. This we have found unnecessary, and on a theoretical basis inadvisable. We feel that if maggots produce enzymes or bring forth favorable substances on the part of the host, meticulous removal of these substances does not appear rational or desirable. We merely mop the wound clean with gauze and remove the remains of the dead maggots, thus saving a great deal of time and effort.

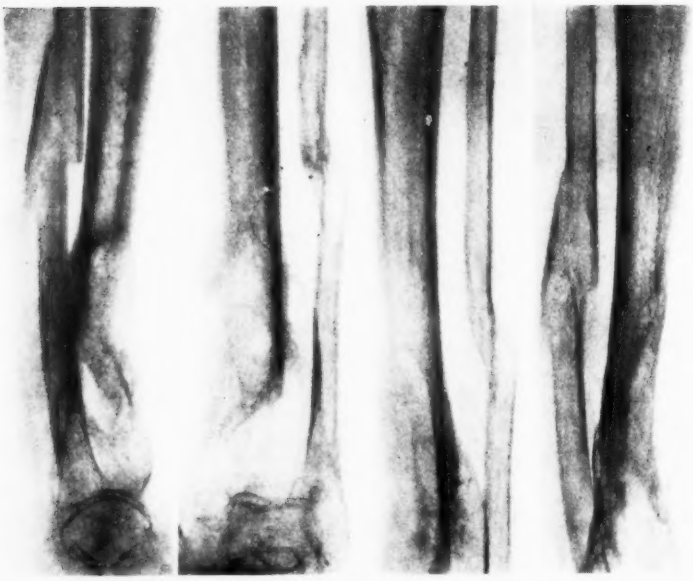

Fig. 16. Fig. 17.

Fig. 16. Case 5. A 47 year old white female sustained a fracture of the right tibia and fibula on December 3, 1929. Because of malposition and delayed union an open operation was performed and an ivory peg was inserted. Osteomyelitis developed. A saucerization operation and Orr treatment was instituted on August 14, 1930. The condition progressed very poorly and amputation was considered before the patient came under observation. On January 9, 1931, a saucerization operation was performed and maggot therapy was instituted. Roentgenograms show condition before last operation.

Fig. 17. Case 5. After 5 maggot dressings. The patient was discharged after a period of 2 months from the date of operation with the wound healed save for a small area lacking epithelium. This picture was taken 10 months after that shown in Figure 16. Note character of repair, reformation of cortices, lack of irregularities in calcification and approximation of appearance toward the normal.

The subsequent progress of the wound is very surprising indeed. Within one to several days the acid reaction becomes alkaline. The bacterial count diminishes rapidly. Any odor that may be present is cleared up. Purulent and irritating discharges disappear and are replaced by a very abundant, serous, non-irritating discharge which must be continuously drained off lest the maggots be drowned. Within several days, the aspect of the wound changes completely. Under the cover of a thin and easily removable dirty gray pellicle, fine, pink, and firm granulations appear rapidly, and begin to fill the wound from the bottom up. After a variable number of such dressings, depending upon factors to be discussed later, the wound becomes obliterated. The resulting scar is soft, and only infrequently adherent or depressed. In those instances in which the dressings are not changed at about the time of the death of the maggots, the wound becomes filled with a thick, purulent, odoriferous discharge which is easily eliminated by the introduction of a new batch of maggots.

The number of dressings necessary to fill a wound completely varies with the age of the patient, the size of the wound, the extent of scarring of the part due to chronicity, previous operations, and lymphatic changes, and above all upon an uninterrupted course of maggot dressings. In children whose limbs are not scarred or extensively indurated by the chronicity of the process, six or seven dressings

may be sufficient for a well and thoroughly saucerized area. On the other hand, in an adult who has had a long standing condition, many operations, and a brawny limb with lymphatic changes, a considerably greater number of dressings and a proportionately longer period of time are necessary for the filling in of the wound.

The latter type of case is at times complicated in our experience by sudden rises of temperature to 104 or 105 degrees F. within 24 to 48 hours of the introduction of the maggots. In several of these cases the limbs presented an erysipeloid appearance, with bullæ formation. The general condition, however, remained good and after about 48 hours the temperature, local heat, swelling, and tenderness subsided. These reactions are apparently due to the opening of chronically infected lymphatics by the action of the maggots. At any rate, this complication, although at first alarming, is apparently of no great consequence. In the first few instances, we removed the maggots from the wounds, but, on subsequent occasions, the treatment was not interrupted. Warm wet dressings of magnesium sulphate eased local condition greatly.

Throughout the treatment, the general condition of the patient is good; the temperature, pulse, and respiration range about the normal level. There is little or no discomfort save that incidental to occasional sharp twinges of pain resulting from the incessantly active and crawling maggots when they strike sensitive spots. These twinges may be sufficient at times to keep the patients, especially adults, awake at night and may necessitate the use of sedatives. Several times, we were compelled to remove the maggots temporarily.

We have been impressed, as was Dr. Baer, with the character of the healing that occurs under the influence of maggots. As previously noted, the wounds present a type of healthy granulation tissue which is rarely seen under other conditions. The soft tissues about the wound remain soft and non-adherent to the bone. In several cases which necessitated secondary operation, we were strongly impressed with the lack of scarring and the macroscopically normal appearance of both the recently deposited bone and soft tissue. We, as well as our roentgenographer, Dr. Pomeranz, have noted that roentgenographically the newly deposited bone is characteristic and different from that noted in other methods of treatment. New bone formation in these cases is smoothly and evenly calcified and does not present the blotchy appearance seen in other types of healing of osteomyelitis.

As previously stated, our experience with this method has not extended over a sufficiently long period of time to enable us to give a statistical study to show either the number of treatments or the length of time necessary to heal wounds, or the frequency of recurrences. We are favorably impressed, however, with the very satisfactory character of the healing processes, the rapidity with which these take place, the lack of extensive scarring, the improvement of the general well-being of the patient, and the lack of untoward incidents in the great majority of cases. All of this, however, is dependent upon a very thorough and radical removal and saucerization of the involved parts. Under this system of therapy we have never noted any excoriation or the least irritation of the surrounding parts, even though we studiously avoided any form of protection. The maggot therapy does not necessitate the minute, caretaking, time and effort consuming technique involved in the dakinization of wounds. The maggot treatment is furthermore more appealing than the Orr technique in that healing takes place more rapidly, gives better scars, and does not routinely necessitate prolonged periods of immobilization in plaster of Paris, nor is it characterized by any offensive odor. However, the period of hospitalization may be longer than with the Orr method, which allows temporary discharge from the hospital during the intervals of dressings. If the consideration of expense is a factor, the method under discussion is more expensive than either the Dakin or Orr treatment, for the expense involved in culturing or buying maggots from commercial houses is considerable.

CASE REPORTS

We cite the following cases as examples of the efficiency of the use of maggots in chronic osteomyelitis.

CASE 1. A. H., a 10 year old white male, complained on admission to the hospital of pain, deformity, and inability to use his lower limbs, and of discharging sinuses of both legs, of 9 months' duration. The onset was characterized by high fever, pain, and swelling of the right leg. Two weeks thereafter, two sinuses appeared with a profuse discharge of pus. A few weeks later, the left leg was similarly involved with like consequences, and after several months, pain appeared in his right arm, subsiding again in a few weeks.

Examination revealed that the patient was in a very poor general condition, underweight, undernourished, and totally disabled. He presented marked flexion adduction deformities of both hips with a great loss of motion at these joints. There were flexion deformities, partial subluxation, and limitation of motion of both knees. The feet were in marked equinus and immobile. There were in addition, discharging sinuses in both legs and several healed bed sores over the sacrum, back, and about the greater trochanters. Roentgenographic examination showed an extensive osteomyelitis involving both tibiæ, the right fibula, and a destructive arthritis of the right knee joint.

In view of the poor general condition, the patient was given supportive measures and after a month's care, he improved considerably. Because the extent of the involvement of both tibiæ was similar (Fig. 5), it was decided to treat the left limb by the Orr method and the right limb by the maggot technique. A saucerization and Orr dressing were therefore performed on the left tibia on March 20, 1931. On April 3, 1931, a similar procedure was carried out on the right tibia, but the Orr dressing was omitted. After a period of 6 weeks, during which four maggot dressings were applied, the wound was entirely healed save for a very small area which was slowly being epithelized. On June 24, 1931, the right fibula was saucerized, and after a period of 2 months during which eight maggot dressings were applied, this wound also healed save for a small area lacking epithelium. At the end of 9 weeks, this wound was completely healed. On the left side, the control side, a number of Orr dressings were performed but after a period of 6½ months, a discharging sinus persisted.

A comparison of both limbs at this time showed that on the side treated with maggots, both operative wounds (one after 7 weeks, and the other after 9 weeks) were perfectly healed, the scars were excellent, and have remained so to date. Furthermore, the wounds had filled up to the level of the surrounding tissues. On the control side, there was a persistent sinus after 6½ months of treatment, and the scar was considerably depressed. Comparative X-ray studies showed that the limb treated with maggots presented an evenly calcified bone scar of excellent texture and appearance, while on the control side, the bone deposition was irregular with areas of sclerosis, rarefaction, and evidence of remaining osteomyelitic activity.

It was, therefore, decided to re-operate upon the control side and institute the maggot treatment. On October 2, 1931, the left tibia was explored and saucerized. Operation revealed several areas of granulation tissue and a perforation of the posterior cortex which was not found at the previous operation. Since the second operation, eleven maggot dressings have been applied and the wound is now completely healed after a period of 10 weeks. X-ray examination (Fig. 6) revealed satisfactory healing. The bone regeneration was homogeneous, smoothly and evenly calcified.

During the course of these events, a sinus appeared over the right humerus and a roentgenographic study (Fig. 7) revealed an extensive chronic osteomyelitic process with sequestrum formation. This area was saucerized on September 4, 1931, and the maggot treatment was instituted. Fifteen maggot dressings were applied, and now, after a period of 14 weeks, the wound is practically healed. X-ray examination (Fig. 8) at this time shows a homogeneously calcified bony regeneration.

The case presented an unusual opportunity for comparison of the Orr and the maggot techniques under ideal conditions. The results are so contrasting that we are left with the impression that the maggot treatment in this individual was more effective from the point of view of rapidity and character of the healing processes.

CASE 2. A. P., a 35 year old white male, gave a history of an acute osteomyelitis of the lower end of the femur 27 years ago, subsequent to an injury he sustained with a knife in that region. Thereafter, he had a severe attack, characterized by severe pain and disability. This subsided without operative interference. Eight years ago, he had a similar attack.

Three weeks previous to his admission to the hospital, the knee became swollen, painful, and disabling. Physical examination on August 3, 1931, showed a flexion deformity of the knee, extension being limited at 160 degrees, and flexion at 120 degrees. Motion between these extremes was painless. There was tenderness along the line of articulation and more so over the lower end of the femur. Examination of the X-rays (Fig. 9) showed an area of rarefaction in the supracondylar and intercondylar regions of the femur. This was surrounded by an area of irregular sclerosis.

On August 7, 1931, a saucerization operation was performed through a lateral approach without entering the knee joint. Two abscess cavities were encountered; one about 3/16 of an inch in diameter, containing seropurulent material; and another, 3/8 of an inch in diameter, containing thick yellow pus. The latter cavity had perforated into the popliteal space. A culture taken from the wound showed a staphylococcus aureus hæmolyticus infection.

Six days after the operation, the packing was removed and maggots were introduced. The patient had six maggot dressings in all, and on October 6, 1931, was discharged from the hospital with a small granulating wound. Two weeks later, that is, 10 weeks after the operation, the wound was completely healed. More recent examination revealed that the wound had remained healed, that there was practically no depression, and very little adherence of the scar to the underlying bone. The range of motion about the knee extended from 180 degrees of extension to 90 degrees of flexion. Roentgenographic studies showed evenly calcified new bone (Fig. 10).

The rapidity with which this wound filled without any sinus formation is worthy of note because when one is operating in a bone near a joint, one usually contents himself with an incomplete saucerization for fear of entering the joint. Yet, in this case, despite the incomplete saucerization, the wound filled up rapidly and thoroughly without sinus formation. This fortunate result is we believe possible through the maggot therapy.

CASE 3. A. K., a 13 year old white male, was admitted to the hospital because of a persistent sinus following an acute exacerbation of a chronic osteomyelitis 1 month previously. Five years ago, he sustained a fracture of his left femur which was treated with a Lane plate because of the failure of closed methods of reduction. He apparently had an uneventful convalescence until 2 years later, when an abscess developed at the site of the operation. This was accompanied by pain, tenderness, redness, and swelling. The abscess was incised and drained. One month later, he underwent an operation for the removal of a loose Lane plate, as demonstrated by an X-ray film. The plate and three screws were removed, but the fourth screw could not be found. The wound healed in 8 weeks. Eighteen months later, a sinus appeared, and the following month, the fourth screw was removed by an operation. A sinus persisted, however, for 8 months. After healing, it remained so for 7 months, when it recurred, and persisted for 1 month, at which time the patient came under our observation.

Examination at this time was negative save for the local condition, namely, a scar on the outer aspect of the left thigh, with two discharging sinuses. A roentgen-ray study (Fig. 11) revealed an area of marked sclerosis with irregular bone formation at the junction of the middle and upper third of the femur.

On January 16, 1931, a 6 inch area was saucerized and a culture revealed that the offending organism was a staphylococcus aureus. Eight days later, maggots were introduced into the wound. After two additional maggot dressings, the character of the wound was so excellent that it was allowed to collapse. One month after the operation, the wound was entirely healed, save for a small area lacking epithelium. Several weeks later, the wound was entirely healed and has remained so to date. The scar is soft and non-adherent. An X-ray study showed a satisfactory new bone formation (Fig. 12).

CASE 4. W. C., a 34 year old white male, was admitted to the hospital because of a persistent chronic osteomyelitis of the left femur of 27 months' duration. In November, 1928, the patient sustained a compound fracture of his left femur as the result of a train accident. Following this, he was treated at 5 different hospitals by surgical staffs who were very adept at the methods they applied; namely, dakinization, the Orr treatment, Beck's paste, and a repetition of the Orr and the Dakin methods. During this period he had ten major operations, including a periarterial sympathectomy of the femoral artery, and he was bedridden during this entire interval.

Examination at this time showed a suppurating wound on the inner and lower aspect of the left thigh, a healed scar on the opposite side and a healed scar in Scarpa's triangle. The knee was ankylosed at 150 degrees. The lower half of the thigh and the upper half of the leg were indurated and brawny. A roentgen-ray study revealed a chronic osteomyelitic process involving the lower third of the shaft of the femur with a large excavated area in the medulla in the supracondylar region. This was surrounded by irregularly sclerosed bone. Numerous sequestra were present. The knee was completely ankylosed, and the patella was fused to the femur.

On February 6, 1931, a saucerization operation was performed through an antero-internal approach, the old scar and the entire front of the femur being removed. The bone was found to be sclerosed. The patella and the knee joint were not disturbed. Figure 13 shows the postoperative X-ray appearance of the femur.

Three days later, maggots were introduced. Forty-eight hours later, the patient had a chill, the entire extremity became swollen, red, and presented an erysipeloid appearance. This was accompanied by a rise of temperature to 105 degrees. The maggots were immediately removed and warm magnesium sulphate dressings were applied locally. In 3 days, the systemic condition subsided, and 2 days later, the swelling disappeared. Maggots were again introduced at this time. This was followed by five additional dressings with maggots over a period of 6 weeks, at which time a reaction similar to that described recurred, 3 days after the last dressing. This time the temperature rose to 106 degrees. The maggot dressings were left undisturbed and, after several days, the condition subsided.

The appearance of the wound at this time was somewhat puzzling. The upper half was progressing and healing rapidly and satisfactorily while the lower half presented a large cavity behind the patella. X-ray examination (Fig. 14) showed that the upper

portion of the area operated upon had healed satisfactorily, and that the new bone was homogeneous in character, while the lower half of this region presented alternating patches of sclerosis and rarefaction with sequestra formation.

The patient was, therefore, subjected on May 18 to a second operation which was more radical than the preceding one. The entire patella, save for its anterior covering, and the anterior portion of both femoral condyles were removed. The entire area was then thoroughly saucerized.

During the following 7 weeks, nine maggot dressings were used, and 1 month later, that is, 11 weeks after the second operation, the patient was discharged to a convalescent home, walking for the first time in 33 months. The wound was healed save for a superficial area which was slowly but satisfactorily epithelizing. When the patient was seen 1 month later, the wound was completely healed and has remained so to date. Roentgenographic studies (Fig. 15) at this time showed smooth bone regeneration throughout the area operated upon. No irregular patches of sclerosis or rarefaction were to be seen. The patella had reformed.

The case demonstrates the rapidity with which repair can take place under the influence of maggot therapy, provided the operative procedure is thorough. When one considers the resistance and the chronicity of the case, despite the previous excellent care, one cannot but be favorably impressed with the effect of the maggot treatment.

THEORETICAL CONSIDERATIONS

The rationale of the maggot treatment is less well understood than its laboratory or clinical aspects. The action of the maggot and how it is carried out are still unanswered questions. Dr. Baer believed that the maggot acts primarily as a scavenger, and, secondarily, it induces the secretion of substances by the host which are favorable for the healing processes.

A review of the scanty entomological and experimental literature on this subject reveals some very enlightening information. Wollman states that the conformation of the buccal cavity and that of the upper alimentary tract of the maggot are such as to permit the consumption of liquid foods only. Furthermore, it has been noted that cadavers on which blowfly larvæ subsist undergo rapid liquefaction. This was also shown experimentally by Fabre who planted maggots in tubes of coagulated white of egg, tubes of meat, and tubes of gelatin. In each of these instances rapid liquefaction occurred and these liquids contained the end-products of proteolytic activity. Fabre, therefore, concluded that maggots produce proteolytic enzymes which act on the proteins and break them down into their end-products upon which the maggot thrives.

Guyenot made numerous extracts of whole maggots, of their salivary tracts, and of their digestive tracts, but was unable to demonstrate any enzymes. He, therefore, concluded that maggots do not produce enzymes, but depend for their food upon the action of proteolytic bacteria which they spread as they bore through the tissues they infest. His conclusion with reference to the production of enzymes is incorrect, for liquefaction occurs when sterile media and sterile maggots are used. However, if meat or egg yolk be sterilized at very high temperatures of 120 degrees F. or over, thus precluding proteolytic activity, sterile maggots will not thrive. If micro-organisms, proteolytic or otherwise, be introduced into this medium, maggots will thrive. It is, therefore, evident that maggots will subsist on the products of the proteolytic activity of their own enzymes, the products of the activity of proteolytic micro-organisms, or on the micro-organisms themselves, proteolytic or otherwise.

Clinical observations support these conclusions. As noted in the clinical section of this communication, the introduction of maggots into a wound produces rapidly a considerable amount of fluid substances. Furthermore, the bacterial content of the wound rapidly diminishes.

Our clinical observations lead us to believe that the proteolytic activity and the physical removal of micro-organisms by the maggot are not the only factors in this healing process. If a maggot be placed on the palm of the hand and its tail be held firmly, a tickling or scratching sensation will be experienced as the maggot tries to get away from the restraining finger. Clinically, the sensations of crawling and twinges of pain experienced by the patient are indicative of physical irritation. At times when the maggots are excessively active the wound and surrounding parts present redness

and tenderness and local heat indicative of irritation. Furthermore, when maggots are introduced into wounds toward the end of the treatment when the wounds are very clean, and the maggots become short-lived, the effect is nevertheless a rapid increase in granulations and filling up of the wound. All of these observations lead us to believe that the irritation incidental to the physical presence and milling about of the maggots is sufficiently minimal to stimulate the tissues to growth. This belief is strengthened by our observation that healing is more rapid in children than in adults, and in parts that are least scarred and have least secondary lymphatic changes than in those that have had numerous operations, or have undergone long periods of chronic inflammation; that is, younger and healthier tissues respond more readily to stimulation.

Another important question that has to be answered if the maggot treatment is to be accepted is whether or not there is a systemic reaction. And if so, is it deleterious or not? We cannot as yet answer the question fully, for our experiments are still in progress. Up to the present time, our observations lead us to believe that there is no systemic reaction save that mentioned previously, namely, the sudden rises in temperature noted in some of our cases. Daily blood studies have shown only an occasional and unrelated rise in the eosinophile count.

In view of the fact that it has been demonstrated in infestations with intestinal and cutaneous parasites that cutaneous hypersensitiveness to these organisms frequently develops, it seemed of interest to determine whether a similar hypersensitiveness results in patients under treatment with maggots. Intracutaneous skin tests were therefore performed with sterile extracts prepared from maggots and flies. A slightly positive immediate cutaneous reaction appeared in 5 of 12 patients under maggot treatment for periods ranging between 1 to 6 months. This cutaneous sensitivity seems to be based upon the circulating type of antibody, the reagin, which is the one usually responsible for these reactions in protein hypersensitiveness and in parasitic infestation. This conclusion is justified because passive local sensitization of normal skins with the serum of some of these patients has been accomplished by the technique of Prausnitz and Kuestner. However, the slight degree of sensitivity, induced by maggots in only some of these patients is of no clinical significance, in so far as can be determined from our present investigations in this small series of cases. Further studies along these lines are being made.

The failure to react to the presence of the maggots may therefore be taken as presumptive evidence that the maggot therapy had no deleterious effect upon the human system. The converse is also true, that is, the human system does not produce substances harmful to the maggot. At first sight, it appeared that this was not so, for it had been noted that after a number of treatments in a given wound the maggots became short-lived. Further study led to the belief that the shortening of the life span of the larvæ was due merely to a gradual diminution of sustenance as the wound cleared up and became smaller. This was demonstrated in one of our cases with two wounds at different stages of healing. In these the life span of the maggots was different; longer in the more recent lesion, and shorter in the older wound. From this we deduce that the longevity of the maggot depends upon local and not systemic conditions. In addition, we have noted that the wound secretions present at the time of death of the maggots are harmless to newly introduced larvæ. One may, therefore, conclude that the relationship of the maggot to the human system in the treatment of suppurative wounds does not give rise to harmful effects upon either one or the other.

And now we come to another question, which, in view of all the work done, may sound rather facetious. Do maggots eat, destroy, or remove dead bone? Our answer is no, they do not. Experiments performed *in vitro* with bone, be it either dead in the form of sequestra or living at the time of removal from the body, show that maggots will remove about one-half of the bone by weight, leaving a framework of honeycombed bone intact. Clinically, it has been our experience that devitalized bone is not removed by the maggots. This naturally leads us to the admonition that

the operative procedure must be thorough and complete; otherwise, sinus formations will occur, necessitating secondary operations.

SUMMARY

In closing, we wish to present our impressions of the maggot treatment of osteomyelitis. They are studiously tempered with conservatism to overbalance the enthusiasm of the investigators in their study of something new and very promising. On the whole, notwithstanding the great deal of work, trials and expense incidental to this method, we are of the belief that the maggot therapy is safe, efficient, and productive of good results—results at times so rapid and excellent as to overshadow all other methods available to us. One need but watch the daily change in the appearance of the wound, its gradual obliteration without the extensive scarring noted in other methods and the comparative comfort of the patient, to realize that the maggots are instituting a superior process of healing. We feel, however, that before this treatment becomes general, further study and experimentation is necessary to elucidate many problems and questions that arise, and to insure a continuous supply of maggots—a very difficult problem—upon the success of which will depend the popularity, applicability, and success of the treatment.

This work has been made possible by the beneficence of the management of the Hospital for Joint Diseases under the leadership of Dr. J. J. Golub, to whom we are grateful for his patience and encouragement. We are thankful to Drs. Samuel Kleinberg and Henry L. Jaffe for their advice and support. We also wish to express our gratitude to Dr. Julius Kreitman for his unstinted assistance in the care and handling of the clinical and operative material, to Dr. Matthew Walzer for his experiments in hypersensitiveness, and to Miss Silka Stocker and Miss Frances Hallman for their untiring work in the culture of the maggots—the backbone of the treatment.

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AVERTIN IN GYNECOLOGY

A Report of Three Hundred Consecutive Cases

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SINCE ether was introduced in 1846, there has been a constant search for the ideal anæsthetic, which (1) should induce anæsthesia as gently and naturally as sleep itself; (2) should not irritate in its administration or elimination; (3) should make the awakening of the patient as natural as from a deep sleep, without nausea, headache, or intestinal paralysis; and lastly, (4) should produce sufficient relaxation for the performance of the operation desired without the operator fighting the abdominal muscles or the intestinal coils.

With this ideal in mind, Halstead introduced local anæsthesia, and Corning spinal anæsthesia in 1885. These two types of anæsthesia have been improved and developed to the point where they occupy a very important place in surgery. Later nitrous oxide, ethyl chloride, ethylene, and sodium amytal were introduced, but these are not ideal anæsthetics.

In 1847, Pirogoff first advocated rectal anæsthesia. This method of administration has never been popular, Gwathmey's ether in oil being possibly an exception. In 1923, Duisberg and Willstaetter prepared tribomethanol for rectal administration. In 1925, Butzengeiger presented this anæsthetic before the Berlin Surgical Society, but it was not until 1927 that Eichholtz demonstrated its true anæsthetic properties. Since that time at least 250,000 cases have been reported in the literature of Germany, England, and the United States.

Chemically the drug is tribromethyl alcohol and is commercially known as avertin. The pharmacological actions have been studied by Eichholtz, Straub and later by Bruger, Bourne, and Dryer, of Montreal. They have shown that the drug is absorbed very rapidly from the rectum and that it is eliminated by the kidneys in combination with glycuronic acid. It is estimated that 80 per cent of the drug is absorbed in the first 20 minutes and that it has no ill effect upon the bowel. When first used, there were cases of severe irritation of the bowel and even gangrene, but this was due to the fact that in preparing the drug it was heated to too high a temperature; the drug was broken up and the irritation caused by the dibromacetoldehyde eliminated. Bruger, Bourne, and Dryer have shown that avertin has very little action upon liver function and causes only a slight kidney depression; that the blood bicarbonate is very little affected, that the hydrogen-ion concentration of the blood is increased, and that there is a definite fall in body temperature.

At the present time we are prepared to report our observations in 300 consecutive cases, as shown in the accompanying Table I.

In this series of 300 cases, 186 patients or 62 per cent received avertin only, 110 patients or 36.66 per cent avertin plus nitrous oxide, and only 4 patients, or 1.33 per cent, avertin plus ether.

There were 172 laparotomies in which in 58.14 per cent avertin only was given, 39.54 per cent avertin plus nitrous oxide, and 2.32 per cent avertin plus ether.

In 128 vaginal operations, avertin only was administered in 67.18 per cent and in 32.81 per cent avertin plus nitrous oxide.

Carbon dioxide was given slowly in 25 cases to stimulate the respiratory center, caffeine sodium benzoate in 47 cases, and ephedrine in 25 cases.

In the anæsthetic charts 1 to 5 which accompany this article, the action of these stimulants may be noted.

In all of the cases the same methods of preparation and administration have been used. The evening before operation, a cleansing enema was given, and 10 grains of chloretone. The morning before operation, no enema was given but 10 grains of chloretone were given at 6 a.m. One-half hour before the ad-

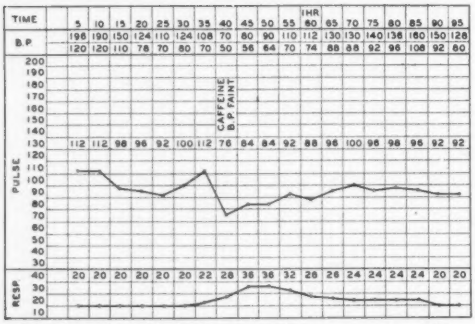

Chart 1. Anæsthesia chart showing response to caffeine sodium benzoate after supravaginal hysterectomy and bilateral salpingo-oophorectomy for fibroma of the uterus and bilateral salpingo-oophoritis. Patient weighed 161 pounds. Before anæsthetic was given patient received ¼ grain of morphine and 1/150 grain atropine; during the anæsthesia at 10:35 a.m., 1 ampul of caffeine sodium benzoate. The avertin was administered as follows: 268 cubic centimeters of 3 per cent solution; rate, 110 milligrams per kilogram. The administration of the anæsthetic was begun at 9:55, patient was sleeping at 10:00; operation was begun at 10:26, ended 11:25. Patient was returned to bed at 11:27; anæsthetist left patient at 11:30. Pulse was 92, respiration, 20. Patient's condition was fair before, during, and after operation.

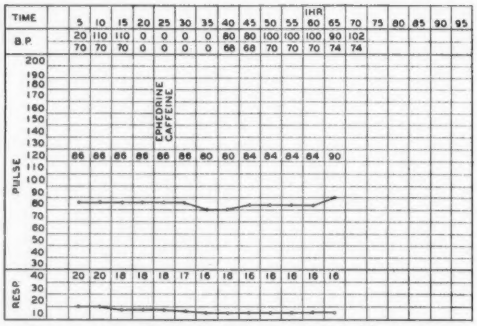

Chart 2. Anæsthesia chart showing fall in blood pressure and response to ephedrine and caffeine sodium benzoate in operation for prolapsed uterus, cystocele, and rectocele. Operation consisted of amputation of cervix, interposition operation, perineorrhaphy. Patient weighed 135 pounds. Before anæsthetic was administered ¼ grain morphine and 1/150 grain atropine were given; during anæsthesia 1 cubic centimeter of ephedrine and 1 ampul of caffeine sodium benzoate. The avertin was given as follows: 234 cubic centimeters at the rate of 110 milligrams per kilogram. The administration of the anæsthetic was begun at 10:10, patient was sleeping at 10:14; operation was begun at 10:45; ended at 11:26. Patient was returned to bed at 11:30. Anæsthetist left patient at 11:30. Pulse was 90, respiration, 16. Patient was in fair condition before, during, and after operation.

ministration of avertin ¼ grain of morphine and 1/150 grain of atropine were given.

No enema is given before the administration of the avertin because it might not be completely expelled, and there would result a slow absorption of the drug or an inability to retain the drug when administered. Avertin, without the previous administration of morphine, has been given a trial, but it has been found that the induction is smoother and relaxation much better when the morphine is given. It has not been observed that cyanosis or respiratory depression is increased by its use. The morphine may be omitted in some patients, but should be used in all nervous and hypersensitive people. It is believed the chloretone is valuable in giving the patient a good rest during the night preceding the operation and that its use before the administration of the avertin aids the morphine in securing a smooth, quiet induction.

At first the drug was used in crystalline form and considerable care was necessary in making up the correct solution. Avertin fluid is now employed, 1 cubic centimeter containing 1 gram of the drug. The dose is calculated according to the patient's weight, age, and general health. Sufficient distilled water is added to make a 3 per cent solution and the solution is administered as a retention enema. According to weight the dose varies from 80 to 110 milligrams per kilogram of body weight. With regard to age, it has been found that children tolerate it better than adults and the aged much less than the middle aged. Alcoholics, hypersensitive individuals, and those with acute abdominal conditions need a larger dose, while the adipose and the feeble need much less. In general, those who are hard to anæsthetize by any method need larger doses than the emaciated, feeble, and poor risks. An average dose of 100 milligrams per kilogram has been used and never more than 110 milligrams per kilogram.

It has been noted that the avertin causes a fall in blood pressure varying from 20 to 50 milligrams of mercury; that the jaw drops and that the cough reflex is absent. The absence of this reflex contra-indicates the use of the drug in tuberculosis and bronchiectasis. There may be some cyanosis and the respirations may become shallow. However, neither the fall in blood pressure nor the respiratory

TABLE I.—SUMMARY OF CASES

No. of cases	Type of operation	Avertin only	Avertin plus N_2O	Avertin plus ether	CO_2	Stimulants necessary	
						Caffeine sodium benzoate	Ephedrine
31	Panhysterectomy ± single salpingo-oophorectomy or bilateral salpingo-oophorectomy	21	9	1	12	10	2
58	Subtotal hysterectomy ± single salpingo-oophorectomy or bilateral salpingo-oophorectomy	32	25	1	10	12	8
95	Plastic	68	27	0	3	17	9
34	Sterilization (abdominal)	19	15	0	0	2	0
31	Salpingo-oophorectomy	15	16	0	0	2	5
6	Shortening of round ligaments	6	0	0	0	1	0
4	Exploratory laparotomy	3	1	0	0	0	0
3	Radical panhysterectomy	1	0	2	0	0	0
4	Laparohysterotomy and sterilization	2	2	0	0	0	0
2	Colpotomy	1	1	0	0	0	0
15	Vaginal hysterectomy	9	6	0	0	3	1
11	Vaginal sterilization	5	6	0	0	0	0
1	Vaginal oophorectomy	0	1	0	0	0	0
1	Abdominal drainage	1	0	0	0	0	0
2	Therapeutic abortion	1	1	0	0	0	0
1	Ureteral transplant	1	0	0	0	0	0
1	Excision of Bartholin cyst	1	0	0	0	0	0
300	Total	186	110	4	25	47	25
300	Percentage	62	36.66	1.33	8.33	15.66	8.33
172	Laparotomies						
	Cases	100	68	4	22	27	15
	Per cent	58.14	39.54	2.32	12.81	15.69	8.72
128	Vaginal operations						
	Cases	86	42	0	3	20	10
	Per cent	67.18	32.81	0	2.41	15.62	7.81

Maximum dose of avertin, 110 milligrams per kilogram of body weight.
Minimum dose of avertin, 90 milligrams per kilogram of body weight.
Average fall in systolic blood pressure in 300 cases, 37 millimeters mercury.
Average fall in diastolic blood pressure in 300 cases, 20.74 millimeters mercury.
Average increase in respiratory rate in 300 cases, 10.3 per minute.
Postoperative complications due to anæsthetic: rectal irritation, none; liver damage, none; pneumonia, none.
Deaths, none.

depression should cause any alarm, for the blood pressure may be elevated rapidly by giving 1 to 2 cubic centimeters of ephedrine and the respiratory center stimulated with caffeine sodium benzoate. When the drug was first used the two stimulants were employed frequently but with the administration of the proper dose, it is rare that any is given, since only occasionally does cyanosis or drop in blood pressure follow.

The drug is administered in the patient's room by the anæsthetist and attending nurse. The patient is not told that the enema is the anæsthetic, but that the enema is necessary before the operation. The blood pressure is taken and the enema given slowly. Within 3 to 5 minutes the patient is in a deep sleep and can be taken to the operating room and prepared for the operation. There should be no hurry for it has been found that the patient is better anæsthetized if 20 to 30 minutes elapse between the administration and the beginning of the operation.

Throughout the operation the anæsthetist takes the blood pressure every 5 minutes and keeps the throat open by means of an airway.

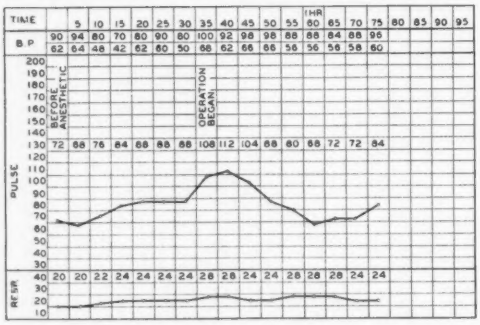

Chart 3. Anæsthesia chart in vaginal sterilization operation after court order. Avertin only was used, no stimulants. Note the slight increase in respiratory rate and the small blood pressure changes. The blood pressure was taken every 5 minutes. One-fourth grain of morphine and $\frac{1}{150}$ grain of atropine were given before the anæsthesia was started. Patient weighed 135 pounds. The avertin was given as follows: 225 cubic centimeters 3 per cent solution, at the rate of 110 milligrams per kilogram. The administration of the anæsthetic was begun at 8:55, patient was sleeping at 9:03. Operation was begun at 9:30, ended at 10:10. Patient was returned to bed at 10:12. Anæsthetist left patient at 10:13. Pulse, 84, respiration, 24. Patient was in fair condition before, during, and after operation.

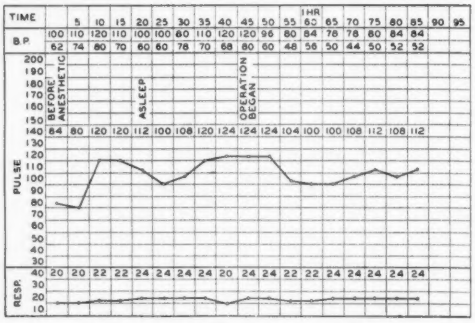

Chart 4. Anæsthesia chart during vaginal hysterectomy for persistent metrorrhagia and chronic catarrhal cervicitis with cystic degeneration. Patient weighed 116 pounds. Before the anæsthetic was given, patient was given, at 7:00 a.m., 10 grains of chloretone and at 8:30 a.m., ¼ grain morphine and $\frac{1}{150}$ grain atropine. The avertin was given as follows: 193 cubic centimeters of 3 per cent solution, at the rate of 110 milligrams per kilogram. The administration of the anæsthetic was begun at 9:08, patient was sleeping at 9:28. Operation was begun at 9:52, ended at 10:32. Patient was returned to bed at 10:35. Anæsthetist left patient at 10:40. Pulse was 112, respiration, 24. Patient was in good condition before operation, in fair condition during anæsthesia and after.

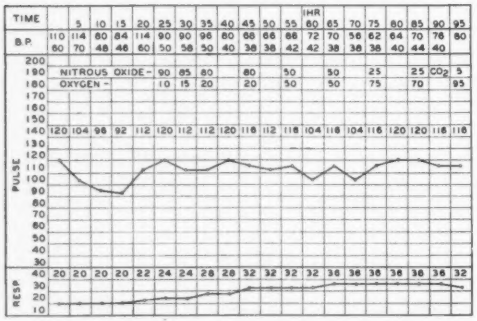

Chart 5. Anæsthesia chart made in a case of bilateral salpingo-oophorectomy. The chart shows the result of the use of nitrous oxide gas to produce sufficient relaxation. Operation was done in a patient suffering with chronic bilateral salpingitis, tubo-ovarian abscess, right; cystic ovary, left. Before the anæsthetic was administered, patient was given ¼ grain morphine, $\frac{1}{150}$ grain atropine, and after the anæsthetic 700 cubic centimeters of normal salt infusion. Patient weighed 114¼ pounds. The anæsthetic was given as follows: avertin and nitrous oxide gas—183 cubic centimeters, 3 per cent, at the rate of 110 milligrams per kilogram. The administration of the anæsthetic was begun at 8:54, patient was sleeping at 9:22. Operation was begun at 9:22, and was completed at 10:23. Patient was returned to bed at 10:25. Anæsthetist left patient at 10:26. Pulse was 116, respiration, 30. The patient's condition was good before the operation, fair during the administration of the anæsthetic and fair after the anæsthesia.

The respirations are slow and shallow as in deep sleep, and if there is any cyanosis an ampul of caffeine sodium benzoate is given. If the blood pressure drops rapidly, 1 to 2 cubic centimeters of ephedrine are given. The blood pressure usually becomes stationary or rises as soon as the operation is begun.

If there is insufficient relaxation, nitrous oxide and oxygen are given in the proportion of 75 per cent nitrous oxide and 25 per cent oxygen. In only 4 cases has ether been necessary. These were radical panhysterectomies for cancer of the cervix, and difficult hysterotomies. With this small amount of nitrous oxide, there is as much relaxation as under deep ether anæsthesia. The respirations are shallow and there is no fighting with intestinal coils pushing into the operative field, whether the operation is an abdominal or vaginal hysterectomy. In fact, in many cases a pack is not necessary to keep the bowel coils out of the field but is used only to prevent trauma to them.

This anæsthesia lasts for 1½ to 3 hours. Then the patient usually falls into a normal sleep that may last 8 to 10 hours. Many of the patients operated upon at 9 a.m. awaken

at midnight and ask when their operation is going to be done. There is little postoperative nausea or vomiting. There is a complete amnesia lasting from the time of administration until the patient is fully awake. There are very few gas pains. Since avertin has been used the patients have very few, if any, gas pains except in those cases in which the bowel is traumatized in separating adhesions. Because there is little postoperative nausea and vomiting and very few gas pains, the patient's convalescence is more comfortable and rapid.

CONCLUSIONS

Avertin more nearly approaches the ideal anæsthetic than any other drug which has been employed in the clinic, because it—

1. Induces a deep sleep very smoothly,
2. Causes very little postoperative nausea and vomiting,
3. Produces a complete amnesia,
4. Fewer gas pains follow its administration,
5. It irritates none of the body organs, either in the process of its administration or in its elimination.

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INDICATIONS FOR AND TECHNIQUE OF ILEOSTOMY IN CHRONIC ULCERATIVE COLITIS

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VARIOUS forms of medical treatment of chronic ulcerative colitis have apparently yielded encouraging results. Crohn and Rosenberg reported favorably on irrigations with acriflavin. Burnford was enthusiastic about ionization. Haskell and Cantarow expressed the belief that systemic treatment with para-thor-mone and calcium is highly beneficial. These and many other methods of treatment, totally at variance in general principle, suggest a groping for specific treatment. Favorable reports have been issued on the use of some form of immunizing agent. Soper, Fradkin and Gray, Streicher and Kaplan, Lynch, Portis, Rouse, Kracke, Surmont and Buttiaux, Muniz, Chisholm, Debenedetti, Horgan and Horgan, Bargen, and Rosenow and Fasting represent only a small number of those who have reported good results with the use of vaccine prepared from the diplostreptococcus so commonly found in ulcers in these cases. We have reported further good results with the use of the specific antibody solution (concentrated serum).

In an effort to evaluate the present status of ileostomy for chronic ulcerative colitis, we have reviewed the 82 cases in which this operation was performed at The Mayo Clinic in the decade 1921 to 1930, inclusive (Table I). The ages of the patients varied from 7 to 61 years. One patient was in the first decade of life, 4 patients were in the second decade, 22 in the third, 32 in the fourth, 17 in the fifth, 5 in the sixth, and 1 in the seventh. Fifty-two patients were males, and 30 were females.

Twenty-six patients were farmers, 12 were housewives (about equally divided between city and country), 6 were clerks, 6 were school children (3 girls and 3 boys), 5 were merchants, 2 were lawyers, 2 were engineers, 2 were mechanics, 3 were teachers, 2 were laborers, 2 were restaurant owners, 2 were carpenters, and 1 each was a bridge foreman, bank cashier, railroad agent, railroad fireman, insurance agent, manufacturer, druggist, chauffeur, painter, dental technician, draftsman, and 1 without occupation.

Eleven of the patients came from Minnesota; 7 from South Dakota; 7 from Iowa; 6 from Illinois; 5 each from Wisconsin, Michigan, Montana, and Indiana; 4 from New York; 3 each from Kansas, North Dakota, and Colorado; 2 each from Texas, Missouri, Mississippi, Oklahoma, and Saskatchewan; and 1 each from Ohio, Alabama, Nebraska, Wyoming, Virginia, Alberta, Manitoba, and Mexico.

One patient had been ill for 1 month, 5 patients for 2 months, 4 from 4 to 6 months, 4 from 6 to 8 months, 1 patient from 8 to 10 months, 1 from 10 to 12 months, 10 patients from 1 to 1½ years, 2 from 1½ to 2 years, 13 from 2 to 3 years, 6 from 3 to 4 years, 11 from 4 to 5 years, 4 from 6 to 7 years, 4 from 7 to 8 years, 3 from 9 to 10 years, 4 from 10 to 11 years, 1 patient for 12 years, 1 for 14 years, 1 for 17 years, 2 patients for 19 years, 3 for 20 years, and 1 patient for 25 years.

The time elapsing between a patients' first admission to the clinic and ileostomy is of interest for it suggests the trend in therapeutic methods. Forty-one patients were operated upon less than a month after their first admission; their disease, in the main, was long standing, complicated or severe. Twelve patients were operated on less than 2 months after their first admission, 5 less than 3 months, 1 patient less than 6 months, 2 patients less than 8 months, and 2 less than 10 months. Two patients were operated on 1½ years after their first admission, 4, 2 years; 3, 3 years; 1 patient, 4 years; 4 patients, 5 years; 2, 7 years; and 1 patient 8 years.

The various treatments used preliminary to ileostomy have been listed by years.

TABLE I.—DATA ACCORDING TO YEARS

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Total
New patients	49	46	57	63	102	134	154	189	197	202	1193
Ileostomies	6	9	16	13	8	12	3	5	8	2	82
Deaths among patients not operated on	5	4	7	6	6	9	4	4	6	6	57

In 1921, treatment ranged from none to irrigations with hot water, local treatment with bismuth and olive oil, chinisol and witch hazel; in one case appendicostomy was performed, and in one tonsillectomy.

In 1922, treatment included hypodermic injections of emetin hydrochloride (this was given in one case as a therapeutic test for amœbic colitis); transfusion, irrigations with hot water, local treatment with witch hazel, cautery to ulcers, tincture of iodine, and bismuth and opium powders by mouth.

In 1923, treatment included emetin hydrochloride, transfusions, tincture of iodine by mouth, irrigations of the colon with hot water, argyrol, silver nitrate, boracic acid, and instillations of olive oil. Treatment prior to the patient's registration at the clinic sometimes included milk diet, Battle Creek diets, osteopathic treatments, and hospitalization in sanitariums for the treatment of tuberculosis.

In 1924, treatment included tincture of iodine, kaolin, bismuth, iron, paregoric by mouth, irrigations with hot water, local treatment with witch hazel, intravenous injections of gentian violet, and transfusions.

In 1925, one patient received vaccine filtrate, two patients received vaccine, others were given local treatment with witch hazel, one patient had infected teeth removed, and one received calcium by mouth and para-thor-mone.

In 1926, treatment included vaccine filtrate and vaccine, para-thor-mone and emetin hypodermically, iodine, paregoric, kaolin, calcium, and stovarsol by mouth. Tonsillectomy was done in one case, irrigations with physiologic sodium chloride solution in one, and argyrol in one. In two cases the whole serum was given for the first time.

In 1927, treatment included vaccine, serum, transfusions and mercurochrome and gentian violet by mouth.

TABLE II.—SURGICAL INDICATIONS AND MORTALITY ACCORDING TO GROUPS

		Cases	Mortality	
			Early	Late
Group 1	First fulminating attack and progressive failure	9	5	1
Group 2	Chronic, with acute exacerbation and progressive failure	21	8	1
Group 3	Chronic, with acute exacerbation and acute complications, as polyarthritis, stomatitis erythema nodosum, and perirectal infection	8	5	2
Group 4	Chronic, not responding to medical treatment	28	7	9
Group 5	Chronic, with complications as polyposis, stricture, incontinent anus, carcinoma	13	1	2
Group 6	Chronic, with diagnostic difficulties. Mass in left side of abdomen. Lesion in right half of colon (tuberculosis or chronic ulcerative colitis). Lesion in right half of colon (tuberculosis or chronic ulcerative colitis).	3		
Total		82	26	15

In 1928, treatment in the clinic included vaccine and serum, irrigations with acriflavine in 1 case, intravenous injection of neoarsphenamine in 1 case, and ileosigmoidostomy in 1 case elsewhere.

In 1929, treatment included vaccine, specific antibody solution (concentrated serum), emetin, and para-thor-mone hypodermically, removal of infected tonsils and teeth, stovarsol, iodine, bismuth and calcium by mouth.

In 1930, treatment included specific antibody solution (concentrated serum), and insulin to create appetite in 1 case.

The 82 cases will be divided into six groups according to types (Table II).

The causes of death were divided into early and late, the former referring to deaths in hospital before the patients left the clinic after the ileostomy, and the latter to deaths that occurred several months after the patients returned home. In the early group there were 26 (30 per cent); in the late group, 15 (19.5 per cent). Replies were not received from 12 patients to whom letters were sent. The latest information concerning the other 29 living patients was received in January, 1931.

The causes of death of the 26 patients who died early were as follows: general peritonitis, 14; inanition and dehydration, 4; hæmor-

TABLE III.—KNOWN RESULTS IN SEVENTY CASES (JANUARY, 1931)[1]

	Cases	Mortality	Late results		
			Good	Fair	Poor
Group 1	9	6			2
Group 2	21	9	2		6
Group 3	8	7		1	
Group 4	28	17	1	1	9
Group 5	13	2	7		
Group 6	3				
Total	82	41	10	2	17

[1]Twelve of the questionnaires were not answered, but previous information had not been satisfactory concerning 7 and the 5 others were in fair condition.

rhage, 2; and 1 each from abscess in the abdominal wall, postoperative peri-ileostomy infection and exhaustion, pulmonary embolism, carcinomatosis, and myocardial infarction. The causes of deaths that occurred at home, or at the clinic on a second visit, included peritonitis after attempted closure of the ileostomy opening, plastic operation on ileostomy, intestinal obstruction, abscess in the abdomen, multiple fistulas, pneumonia, endocarditis, leukæmia and inanition.

The fact that 52 of the patients were males, may, in itself not be significant, but in our experience it is more difficult to convince women than men of the desirability or necessity of ileostomy.

The age incidence corresponds closely with the incidence of greatest occurrence of the disease. Most patients were in the third, fourth, and fifth decades of life. In recent years we have seen more cases in children but have performed few ileostomies in these cases because surgical complications were rarely present.

The occupations represent the average duties of life, but it is noteworthy that none of the patients operated on was a physician, yet each year we have seen a fair number of physicians with the disease.

In the early years (1921 to 1925), when the condition did not respond to irrigation with medicated solutions and other accepted therapeutic measures, ileostomy was done. In 1926, because of the better results from medical treatment, there was a sudden increase in the number of cases observed, including many in which the disease was advanced. In recent years we have learned that the response to treatment with vaccine and serum is often rather slow and therefore ileostomy should not be done until therapeutic measures have been given months of systematic trial. This is borne out by the fact that in 1930, the year the greatest number of cases of chronic ulcerative colitis were observed at the clinic, the smallest number of ileostomies was performed. The long interval between the first admission and ileostomy in the early cases was due to the fact that many patients who did not respond to conventional treatment went home, and when the disease progressed and complications developed, they returned for ileostomy.

With regard to preliminary treatment, it is sufficient to say that by present methods the disease of fully 75 per cent of these patients coming to the clinic is controlled. Streicher recently stated that complete relief of symptoms was obtained by medical treatment in 84 of the 102 cases (approximately 80 per cent), and Gray gave similar figures following the subcutaneous administration of vaccine.

The causes of unsatisfactory progress after ileostomy follow closely the type of case. Many of the 29 patients known to be alive in January, 1931, were not satisfied with the results of ileostomy; others were wholly unable to earn a living, and were reduced to a state of chronic invalidism (Table III).

In 10 cases of group 4 the patients reported 6 to 9 years later that rectal discharges of blood streaked purulent material persisted as before operation. Six patients from group 2 reported 2 to 8 years later that their trouble continued as before and that they were unable to carry on their occupations. Two patients from group 1 reported 1 and 6 years later that their trouble continued. The one patient of group 3 reported 7 years after operation that he was 50 per cent better.

It is exceedingly difficult to evaluate these results as each case has been an individual problem. We cannot state that ileostomy might better have been postponed or even not attempted, since we are convinced that it has saved some lives. It is in the acute phase of the disease that the question of operation is

debatable. In groups 1, 2, and 3 (Table II), in which cases of the acute phases of the disease were classified, there are 38 cases, and the early operative deaths were 18 (47 per cent). Of the 20 patients who survived the immediate operation, 16 are still living but the condition of 8 of them has not improved. We believe that in these particular groups our present medical regimen offers more than surgical treatment, besides sparing the patient the annoyance of ileostomy. Undoubtedly an occasional case will be an exception. The discouraging results in 33 of the 38 cases (the 18 operative deaths and the 4 later deaths) certainly make us feel that operative treatment should be undertaken only after the most intensive and thorough medical treatment.

In group 4 (Table II), the chronic cases, in which surgical treatment was selected after discouraging trial with medical treatment, it is logical that poor results would occur. The patients had been depleted by disease for months, usually years, and changes in the heart, liver, and kidneys existed in addition to severe infection of the walls of the colon. The immediate mortality was 25 per cent, about half that in the acute cases. Nine patients (32 per cent) died later, and 10 of the surviving patients are chronic invalids (Table II). One patient reported that he was in good condition, and another, although still having trouble, was able to work most of the time. From the study of these four groups (Table II), it is difficult to escape any conclusion other than that uncomplicated chronic ulcerative colitis is primarily a medical disease and only in rare instances is surgery advisable.

The question of deciding whether to close the ileostomy opening or to perform ileosigmoidostomy is also difficult. Closure was safely effected in 1 case, 1 year after ileostomy, but 2 years later the patient suffered an acute exacerbation of the disease which was treated medically.

Incidentally it may be noted that appendicostomy had been performed in 2 cases and cæcostomy in 1 case prior to admission; the operation had been of little, if any, value. In 1 case colostomy, in the lower part of the descending colon had been done, and later ileostomy was done.

Ileosigmoidostomy had been performed in 2 cases; in 1 case at the clinic and in 1 elsewhere. The latter patient had become discouraged by medical treatment at the clinic and went elsewhere for the operation. Following this, he became much worse; the stools increased from 8 to 10 daily to 20 and 25. He returned to the clinic, when ileostomy seemed the only possible procedure, especially after another short trial of medical treatment. The operation was performed and death resulted from peritonitis. In 1 case ileostomy had been done a year previously. The condition seemed quiescent but following ileosigmoidostomy, peritonitis and death resulted. In the third case, ileostomy and subtotal colectomy had been done and ileosigmoidostomy was finally undertaken. The patient survived the operation but died 5 months later from an acute exacerbation of the colitis; undoubtedly the onset was in the rectum with rapid extension into the ileum. We feel that after ileostomy has once been established, it must be considered permanent. We also feel that the present type of treatment may finally control the disease and make it possible to institute surgical procedures in the form of ileostomy, since cæcostomy and ileosigmoidostomy yield so little in the way of relief.

Ten patients are known to be in good health and are satisfied with ileostomy, because of striking relief from the trouble for which the ileostomy was performed. Seven of these operations were performed for complications of chronic ulcerative colitis (group 5, Table II), including polyposis, stricture, perirectal abscess, and absence of anal sphincter, the result of fistulectomy elsewhere. Five other patients reported that they were doing fairly well and were able to work, but that rectal discharges of blood and pus continued. Naturally the mortality is low as the disease is not acute nor is the patient so likely to be depleted. We have no recent data on 4 cases of this group. The 3 other patients known to be well were of groups 2 and 4, and one would be justified in assuming that ileostomy had not only saved their lives but had made it possible for them to go on as useful citizens.

Unquestionably, patients with polyposis, strictures of the bowel, incontinent anus, and carcinoma should have surgical intervention, and it is gratifying to know that ileostomy can be performed at a reasonable risk (15 per cent) for such a disease as chronic ulcerative colitis. The risk is really less than this in a case in which it is reasonable to expect a good result, and, as will be pointed out later, with the development of the more recent type of ileostomy, considerably less. One of the 2 deaths in group 5 (Table III) was due to diffuse carcinomatosis of the colon, and the other was due to peritonitis following repair of the ileostomy.

COMMENT AND TECHNIQUE

The foregoing data seem to be ample evidence that surgery has failed to be of great benefit in many cases of acute ulcerative colitis, and they furnish proof that it is indicated, apparently, in only the chronic, complicated, long standing cases, which have failed to yield to medical, dietary, and other therapeutic agents. We have not shared the optimism concerning satisfactory end-results following appendicostomy and cæcostomy, which a review of the literature would indicate to exist. Unquestionably, many patients have been benefited by these procedures but the rationale of the operation is questionable and, certainly, if any patient is desperately ill with chronic ulcerative colitis, much is asked from any type of operation. One might readily question subjecting the patient with the acute fulminating type of disease to surgical procedures, and, indeed, a statistical study of the end-results makes it rather plain that little is to be expected from this type of treatment. Ileosigmoidostomy (17) has been fairly frequently mentioned in the literature and in the past it has been accomplished successfully in many instances, so far as the operative mortality is concerned. It is our belief that this type of procedure, in cases of chronic ulcerative colitis, should be mentioned only to be condemned.

Our experience indicates that chronic ulcerative colitis is initiated in the large bowel, almost invariably, from the rectum upward. True, there are sporadic instances of markedly localized chronic ulcerative colitis and other instances in which apparently it has been found in its earlier stages in the right and middle segments of the colon, but for all practical purposes, one may consider it a disease which begins in the rectum and progresses toward the cæcum and ileum. To attempt to make an anastomosis in a sigmoid which is infected with chronic ulcerative colitis is hazardous from the standpoint of immediate operative mortality, and there is little reason to believe that a high percentage of such patients would receive even transitory benefit from side-tracking the greater part of the large bowel by this method.

We have preferred to use ileostomy without exploration in the more acute cases in which operation seemed imperative. With increasing experience, we have found a decided falling-off in the number of cases selected for operation, so that during the last year, in The Mayo Clinic, ileostomy has been performed only twice. The unsatisfactory end-results have been a deciding factor in abandoning surgical procedures in the acute, fulminating cases, and in limiting them, so far as possible, to the group of cases which, on account of their chronicity, complications, and marked disability of the patient indicate radical measures for relief. A corollary to this statement is that chronic ulcerative colitis, in its later stages, must be classified with the condition which not infrequently demands extirpation of the colon because of the development of multiple fistulas, abscesses, or polypoidosis, which we believe to be a precursor of a malignant condition. Because of the fact that in many instances in this type of case it is desirable and frequently necessary to perform subtotal colectomy, or possibly total colectomy following preliminary procedure, we have found it advantageous to change the technique of ileostomy somewhat from that employed in former years.

When Brown advocated a double barreled loop ileostomy for chronic ulcerative colitis, the technical difficulties of the operation were markedly facilitated, in cases in which operation was imperative. However, with the evolution of ileostomy, it has seemed to us decidedly more satisfactory to institute single

barreled ileostomy instead of double barreled. Since the former method of irrigating the colon has fallen into disrepute, the cæcal end of the ileostomy is useless and, protruding alongside the proximal loop, makes an abdominal anus more difficult to take care of. Furthermore, should one desire to resect the colon subsequently, because of any of the indications mentioned, the single barreled ileostomy is a decided help in that it lessens the difficulties of the operative technique and permits one to proceed with the subsequent removal of the large bowel without having to consider so much of an infected field. The type of ileostomy we are describing has been used in 6 cases, as a preliminary step to resection of the colon. Three of the operations were done for chronic ulcerative colitis and 3 for multiple polyposis. The very decided advantages which this type of ileostomy gives the patients, so far as its care is concerned, have inclined us to continue the procedure. There is a disadvantage to a single barreled ileostomy which will be voiced immediately: in the event a stricture develops along the course of the colon due to the chronic ulcerative colitis, it leaves a blind loop of bowel full of pus and detritus without an opportunity for drainage. This, however, is of infrequent occurrence, and moreover it is highly probable that the majority of patients with chronic ulcerative colitis who submit to operation will be subjected sooner or later to partial or total exeresis of the colon.

The technique of this ileostomy is relatively simple. A point midway between the umbilicus and the anterosuperior spine on the right side is selected and a split muscle incision is made. The diagnosis is always established by roentgenograms and proctoscopic examination, and it is not necessary to explore the colon. Indeed, any exploration of the colon, however carefully done, is likely to result in disaster, since even by the gentlest manipulation one may inadvertently thrust the examining finger into the diseased cæcal wall. A point in the ileum, about 12 or 14 centimeters from the ileocæcal valve, is selected and the blood supply to this portion of the bowel is divided between clamps, and ligated; the bowel is then severed between clamps with a cautery. The end nearest the cæcum is inverted with any type of inverting stitch and is dropped back into the abdomen. Between the mesentery of the proximal end of the bowel and the lateral parietal peritoneum, a number of stitches or a single running stitch obliterates the raw space, just as would be done in making a colostomy in the sigmoid on the opposite side. This prevents obstruction by small loops of bowel which might slip behind the ileostomy. In case there is a wide space with small chance of obstruction, this step would be unnecessary. The proximal end, with clamp on it, is brought out through the incision and sutured to the peritoneum by interrupted silk sutures. The wound is closed tight with catgut sutures and a clamp is strapped to the abdomen and allowed to remain unopened for 48 hours. By strict adherence to a regimen of total abstinence of fluids by mouth, and maintenance of the fluid balance by intravenous and subcutaneous injections of glucose and salt solutions, these patients are carried through the first few days following the operation with slight discomfort and without any evidence of obstruction. When the clamp is taken off, the end of the bowel is teased open and a small catheter is thrust into the loop for drainage.

Usually the immediate convalescence is complicated by considerable loss of fluid, and drastic efforts to maintain a satisfactory water balance are necessary. As time goes on and the ileum gradually takes on cæcal function and the stools become semi-solid or formed, it is less and less difficult to take care of the artificial anus and the patient's general condition begins to improve. Operation is instituted considerably later, if necessary.

The care of an artificial anus is of considerable importance to the patient. If the content of the bowel is fluid, disagreeable experiences are the rule rather than the exception until such time as sphincteric control becomes slightly developed and the bowel habit is changed. Of all the devices that have come to our notice as satisfactory for colostomy and ileostomy, one devised by a patient on whom we performed ileostomy for polypoidosis of the colon, has been the most satisfactory.

The important features of the satisfactory ileostomy bag include those which adequately take care of the discharge and those which do not interfere with the patient's æsthetic sense. Thus it is important that the portion of the bag fitting the ileostomy opening shall be as small as possible, both in the anteroposterior direction and laterally, in order that the discharge will be kept away from the skin, that the gas escaping will be taken care of, that the cup may be kept clean easily, and will not tarnish, and finally that the apparatus is light. All of these features have been combined in the apparatus built by the patient in question. The cup is made of monometal. Its anteroposterior diameter is about 2.5 centimeters and the other dimensions about 7 centimeters. It has a ring with a flange, and around this fits a tight rubber dam, made from dental rubber, through which a hole is cut to fit the ileostomy so that the soft dental rubber sheeting is the only part touching the patient's skin. The bag attached to the lower end of the cup can be made of a size to suit the individual needs. Finally, the patient should be taught satisfactory dietary habits (3).

CONCLUSIONS

1. Results from ileostomy in cases of chronic ulcerative colitis are satisfactory if the operation is performed for chronic complications.

2. Ileostomy should not be performed for uncomplicated chronic ulcerative colitis, unless all other measures of treatment have failed, these to include vaccine and serum.

3. Ileostomy should be performed only with the patient's full understanding of its nature as a life-saving measure.

4. Ileostomy for chronic ulcerative colitis should be permanent.

5. The most satisfactory type of permanent ileostomy is the one barrel ileostomy, except in cases of stricture of the colon or when some hope for temporary ileostomy may be held out.

6. The education of the patient concerning the care of an artificial anus is a very important factor for his happiness.

7. No one of the operations—appendicostomy, cæcostomy, or ileosigmoidostomy—has proved a satisfactory therapeutic procedure for patients with chronic ulcerative colitis.

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CLINICAL SURGERY

FROM THE ORTHOPÆDIC HOSPITAL, LOS ANGELES

UNUSUAL CONSIDERATIONS AFFECTING RECONSTRUCTIVE SURGERY FOR PARALYTICS

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FROM the standpoint of end-results, a surgeon of expert technical skill may not accomplish for a paralyzed individual as much as one less gifted, whose judgment is sounder.

By "end-results" we do not mean simply the best possible function, form, and alignment obtained by certain operative procedures, rather, we mean the accomplishment of certain orthopedic surgical procedures, both cutting and non-cutting in type, which will at least make possible the richest and fullest life for the patient.

Many able authorities have described the technique of a great variety of surgical procedures used in the physical reconstruction of poliomyelitis and other cases of paralysis.

It should be of value to students and younger surgeons to point out certain details which are often overlooked or not sufficiently appreciated, which rightly considered, will make them more discriminating in choosing their course of procedure in the pre-operative, operative, and post-operative care of such cases.

In no field of surgery does the chance for the spectacular exist to a greater degree, nor is the imagination of the younger surgeon stirred or intrigued more keenly by the fascination of rendering aid by means of the knife to unfortunate boys and girls, than in orthopedic surgery. It has seemed to us that too great a tendency exists to think of reconstructive surgery in terms of the knife, and that basic facts of sociological and educational import and even of the real physical facts of kinetic dysfunction are not truly evaluated.

As visitors and students we travel to many clinics, and 90 per cent of us (expecially when we are younger) spend 90 per cent of our time in the operating room trying to master the operative technique and studying indications and contra-indications for these particular operations. We accept without question the operator's statement that the operation being performed is specially indicated in that case. The social status, the economic background or future, the educational situation, so momentous in the child's life, his mental status at the time and its future possibilities, all should be understood before surgery is undertaken. Probably they have been by the surgeon operating, but time and opportunity are not available for their discussion in the operating room. It should be remembered that end-results of such surgical procedures as presented to the visiting surgeons may be 100 per cent perfect from a surgical standpoint, but from other angles may not rate so high.

We must bear in mind also that the high degree of success attained by many eminent surgeons does not necessarily mean that it was won by the knife. More than likely such a surgeon is a keen student of sociological matters and has very carefully weighed all that is pertinent to the case in hand and has based his choice of certain appropriate operations or other procedures on his long experience. This may not be at all evident to an observer, however.

The principal general considerations which should be inquired into carefully are: (1) the mental status, present and future; (2) the individual, family economic status, present and future; (3) industrial possibilities; (4) social status.

First, our experience at the Orthopædic Hospital of Los Angeles, during the past dozen years in which we have had opportunity to have the advice of a clinical psychologist, has shown the importance frequently of modifying our operative recommendations. Two cases, briefly mentioned, illustrate this point.

W. B., boy, aged 15 years; poliomyelitis; ample preliminary muscle re-education; one leg nearly dangled at ankle and knee; gluteus maximus about 60 per cent, but

medius weak; able to stand with caliper ring splint and two-inch raise on heel and sole. It was desired to get patient out of a brace, which called for a foot stabilization and an arthrodesis of the knee. A report was requested from the psychologist as to the future intellectual and vocational outlook of the boy. A report was returned stating that the boy was of a "dull normal" mentality and could never be a brain worker. On the basis of this report these operations were done, and the boy was made brace free. Shortly afterward he returned to his home town, obtained a job at a service station where he has been a satisfactory employee for several years.

X, boy, aged 14 years; poliomyelitis, chronic, involving one leg; atrophy, shortening 2 inches, contracture deformity at the knee, equino varus severe in foot. Operations for correction of deformity gave very satisfactory results. Follow-up of muscle re-education failed to give any power at the knee. He had a nominal limp in brace and high soled shoe. One of the younger surgeons felt that probably an arthrodesis at the knee would make him free of the brace. The record showed his father to be a plasterer. Patient was sent through for an opinion from a senior surgeon, and a report from the psychologist was requested. Advice was returned that the boy was distinctly a mental type with a high intellectual quotient and that he had a marked bent toward some artistic career. As a result, operation was advised against and the boy sent home, wearing a brace with a lock stop at the knee joint.

The tendency for some surgeons to perform arthrodesis of hip or knee joints without specific knowledge (as far as can be obtained) can, especially in clinical practice, produce untold harm to the future vocational, social, and mental outlook. Ask a doctor, lawyer, or business executive, with a knee stiff from injury or arthritis, what the handicap means, and one will readily understand that such a condition should not voluntarily be produced except as a necessity or choice after very mature deliberation. Never should it be done early in life in a paralytic until an intelligent effort has been made to evaluate the future social-economic needs and possibilities.

Second, the closer the child is to adolescence and the beginning of the working age, the more careful should the surgeon be to acquaint himself with the family background. Proper social service reports, plus the report on the individual's mental and vocational possibilities will often determine the most advisable surgical procedures. A succession of separate operative steps preceded and interspersed with physiotherapeutic treatments over a 2 or 3 year period might be ideal in certain circumstances, but in a family in a bad economic situation, with the father perhaps dead, or having deserted the family, and the mother working, radical procedures to give stability, reasonable function, and early possibility of work should be decided upon.

We recall certain early criticisms of the work of Hoke and Campbell in the south for the extensiveness and apparent radicalness of some of their surgery but an intimate knowledge of the social problem they have so bravely attacked showed that the majority of terrible paralytic deformities in young adults and children of poor mountain families necessitated this type of radical surgery to meet the absolute economic and social need presented.

There would not be time and money available to do what some might consider a more conservatively indicated course of procedure; hence the criticisms, without intimate knowledge of all the facts to be weighed were unjust.

Third, the industrial aspect of each poliomyelitis case nearing working age should receive careful consideration. We have already mentioned the individual assets in the way of mental equipment, etc., but the surgeon should have some hesitation in performing operations which might render it difficult to execute certain motions essential to an occupation for which the individual might be otherwise well suited.

For instance, arthrodesis of a shoulder may be well indicated but the position in which the shoulder should be permanently fixed may vary considerably according to the occupational requirement and also in accordance with right or left handedness in relation to which shoulder is involved. Likewise with some involvement of both shoulders, which one to stiffen requires good judgment, based on the existing hand and elbow function or the degree of possible function in connection with wrist arthrodesis or transplantation.

This operation is often done quite early without due regard to future occupational possibilities or necessities.

As an instance of the need for caution let us cite the case of a young doctor, who some years ago suffered an attack of poliomyelitis, with resulting extensive, belated leg and trunk paralysis. He was advised, upon consultation with a surgeon of outstanding operative ability, to have an arthrodesis of the hip and knee on one side, to allow him to stand. Fortunately, he did not take the advice and ultimately made fine success as an internist practicing from his wheel chair. He did not have the possibility of doing anything much else without low back and abdominal musculature sufficient at least to avoid fatigue and what would have been his present status had he followed this advice and been unable to sit? His arthrodesis, even in a semi-sitting position, would have been useless for standing, and would have required knee arthrodesis at a corresponding angle which would have raised the foot 4 to 6 inches from the ground, which, with an uncon-

trolled hip joint on the opposite side, would have rendered standing difficult, if not impossible. Stiffening in the straight position likewise would have prevented a good sitting position. This represents a case of when to let well enough alone and not to operate. The axiom of an old time professor of surgery, "if you can't do some good, don't do any harm," was never better illustrated.

Fourth, the present and future social status of the afflicted person should also be taken into consideration in prescribing the surgical reconstruction scheme. Younger surgeons trained in the technique of operative procedures and without long experience and contact with social, business, or industrial aspects of their patients' lives are too likely to give the latter but scant consideration and may not weigh the factors in their proposed operations against the future social status of the individual. Such procedures as arthrodesing knees, hips, shoulders, and wrists should be most thoughtfully considered, first, as to whether or not they should be recommended at all; if so, at what age, and when done what should be the choice of angles at which to fix them.

For illustration, a beautiful girl of 11, with double dangle legs has been in double full length braces for a period of 1½ years, undergoing muscle re-education and training, with the result that no return shows in the feet; only a very slight bit at the knee and some in the thighs, but with only about 40 per cent strength. The senior surgeon decided upon and carried out a bilateral Whitman astragalectomy. He was questioned as to his reason for doing this in the face of the fact that the girl would probaby have to wear braces always. His purpose was made clear when he stated that knowing the social status of the family and the probable future position of the girl he did the procedure because it was sound technically; the knees would be more or less stabilized and there was some likelihood that the abductors of the hip joints might in time reach a strength to allow them to be shifted back to aid the glutei.

Furthermore these feet could be safely shod in low shoes, and sheath type braces with lock stops to control knees and extending only to the skirt length could be worn for dress affairs without showing. The feet thus shod would be presentable and braces would not be in evidence. Later spinal fusion or plastic repair of abdominal insufficiency may still further decrease this girl's disability.

Every one of the poliomyelitis cases should have a well thought out surgical plan based on possibilities and probabilities 10 or 20 years ahead. Each step bears directly on the next. Hence care in not doing too much, and especially not out of sequence, is necessary. After each procedure or series of steps the adaptation of the new mechanical situation to school and social needs becomes necessary. As the child develops, new demands may show the need of further surgery, to withstand increasing weight and activity, or economic and social necessity. Many final or end operations of a radical type like those mentioned should be planned or done late enough to determine their absolute necessity or advisability.

As an illustration of improper sequence in relating surgical steps note the following case of paralytic equino valgus, in a girl of 13.

Patient was seen by senior consultant. Recommendation already given was: tendon lengthening of Achilles and transplanation of peroneus longus to midtarsal region; second step, tarsal stabilization. Advice was given to do the heavy bone work of stabilizing operation as a first step and then the transplants later to avoid danger of complications.

The foot ought not be used in a position of deformity during the period necessary for re-education. Consequently, the early need of the arthrodesing procedure, and this would require 8 weeks in plaster, which would give time enough for atrophy of the transplant with stretching of adhesions. Furthermore, the swelling incident to the latter operation and probability of secondary closure of the dorsolateral incision with a large binding scar not far from the transplant insertion might easily vitiate the entire value of the first procedure. Hence, it is a safe rule to do all deformity correction of bones and joints first and follow by those procedures which deal with re-adaptation of power.

To illustrate the possibilities over a period of years, let me cite one severe case.

A. D., paralyzed at 8 years of age. Both legs, abdomen, and trunk in the lower segment, with the following deformations: advanced scoliosis, pelvis tilted forward and down on the right side; overactive Achilles and peronei, both feet, with weak anterior tibials producing equino valgus, with marked instability and toe drop. Beginning knock knee on both sides with rotatory deviation of the tibia at the knee because of a tendency to overaction of the biceps and overtension on tensor fascia femori; paralysis of the lower half of the abdominal muscles. Patient could stand by use of crutches and with them walked with great instability and lack of security. The following brief résumé of reconstruction illustrates what persistent, thoughtfully planned procedures could accomplish to meet the original condition, anticipate and prevent the effects of deforming forces, and obtain gradually increasing function until at 17 years she has managed to keep up in her grades at school and can sit and stand longer times without fatigue, attend social and school duties, has become practically independent in getting around on short crutches, and lately has begun to stand alone in leg braces without crutches and take a few steps just holding lightly for balance.

September, 1923, to March, 1925, re-educational muscle training.

March 10, 1925, right foot, tarsal arthrodesis; transplant of the extensor proprius hallucis to anterior tibial insertion, peroneus longus to scaphoid. Physiotherapy until November, 1925.

November 3, 1925, left foot. Tarsal arthrodesis. Transplant peroneus longus to scaphoid. Followed two years of gymnastic treatment; underwater muscle training, braces, casts, etc.

October 20, 1927, spinal fusion for severe scoliosis. Four months' recumbency and muscle training.

July 17, 1928. To correct right leg, back of knee, knock knee, and rotation, osteotomy of the tibia, fixation of patella to tibia to form a check to back knee. Two years of school work, treatment and training.

February 7, 1930. Transplant of left biceps to patella.

Improvement was continuous but slow. In an effort to overcome the swing of the right leg forward and the swaying gait due to weakened trunk fixators, study of the abdominal weakness induced us to do a fascial plastic of the abdominal musculature, transplanting fascia lata strips from the upper, healthy portion of the rectus abdominalis to the symphysis and another across out and down from above the umbilicus to the sagging right ilium at the anterior superior spine. This was done July 17, 1931.

At the present writing she clears the floor by 2 inches with the right foot; doesn't sway as much, can stand alone in leg supports without crutches, and can begin to take a few steps without help.

Here we have a kaleidoscopic view of the life of a nearly helpless girl of 8, through 9 succeeding years, now a young lady in high school, still improving. When her mother said, before her last operation was scheduled, "Oh, Doctor, do we *have* to have any more operations?" she only protested, "Gee, Mother, some of the kids have had seven or eight—I've only had five!"

SUMMARY

Plan for twenty years ahead.

Adapt your surgery to the social, industrial, and economic needs.

Consider the family situation.

Consider the existing mental states in relation to future possibilities.

Each operative step bears a definite relation to future ones and may lead to future modification of your tentative plan.

Attack the key situation first and maintain the correct sequence.

Never say "nothing can be done"; rather, "there is nothing I can do at present" (when the possibilities seem slight). Perhaps a better qualified surgeon could do a great deal.

FROM THE MICHAEL REESE HOSPITAL

PELVIC DIAGNOSIS BY ROENTGEN VISUALIZATION

IRVING F. STEIN, M.D., F.A.C.S., CHICAGO

A DECADE is usually required after the description of a new method of diagnosis or treatment before its general acceptance, and although it is just ten years since Peterson's description and recommendation of gynecological pneumoroentgenography, there is already considerable evidence in the literature of its widespread adoption by the profession.

Impelled by the conviction that pelvic visualization is a method which well merits the attention and serious consideration of surgeons practicing gynecology as well as all roentgenologists, we desire to describe the technique of this diagnostic procedure as it is employed at the Michael Reese Hospital, Chicago, and where we have utilized it for the past decade. Pneumoperitoneum was introduced in 1902 by Kelling who injected air into the peritoneal cavity to visualize the abdominal viscera for endoscopy. Later, Jacobaeus tried the method on a series of cadavers and demonstrated that no visceral injury was inflicted by the abdominal puncture. Subsequently, he reported successful results in one hundred living subjects in which no infections and only one case of bleeding was encountered. In his monograph on abdominoscopy published in 1913, he first called attention to the great advantage of combining pneumoperitoneum with a roentgen examination. Orndoff made use of this combination in over one hundred cases and published a beautifully illustrated article on the subject in 1919. He substituted oxygen and nitrogen for air for inflation, and employed chiefly the dorsal and lateral postures in making roentgenograms. There is evidence also that he used the prone position with the hips somewhat elevated for pelvic exposures. Weber, Lorey, and Stein and Stewart (13) were also pioneers in the development of this field of diagnosis.

Carbon dioxide, which has become the medium of choice, was first introduced for the production of pneumoperitoneum by Alvarez, in 1920, who also described the visualization of the uterus and ovaries on the roentgen film after placing the patient in the Trendelenburg posture, thus permitting the gas to surround the pelvic viscera and to displace the intestines.

In 1921, after 10 months' experience with diagnostic pneumoperitoneum in gynecology, Peterson reported favorably upon the method to the American Gynecological Society and recommended its utilization. He not only employed the transabdominal route of abdominal inflation, but also adapted the Rubin patency technique to transuterine inflation. He placed his patients in a modified knee-chest position for radiography thereby obtaining better pelvic visualization than had previously been described. Peterson proved by cultures that both oxygen and carbon dioxide were bacteria-free as they escaped from the needle, and also by the fact that there were no instances of peritoneal irritation in the 300 patients whom he inflated. Commenting upon the value of pneumoperitoneum as a diagnostic aid, Peterson says: "It certainly has been surprising to see how often it has been impossible to determine accurately by the examining finger the exact condition of the pelvic organs. I failed to realize how much I was depending upon the opening of the abdomen to clear up fine points in diagnosis. All this has been changed since roentgenography of the pelvis has been utilized as an aid to diagnosis." Yung also emphasized the value of pneumoperitoneum in gynecological diagnosis, stating that by this method a better differentiation between simple follicle cysts and ovarian tumors can be made, and that conservatism in surgical treatment of myomata during the reproductive period may be clearly indicated. He points out the value of demonstrating normal pelvic findings to exclude pelvic adhesions, a diagnosis which leads to so many unnecessary operations. A great many publications have appeared on this subject in this country, in continental Europe, and in South America; in all of these contributions the advantages of pneumoroentgenography have been stressed. Accidents have been exceedingly rare—about one in two thousand cases—and were usually due to careless technique. Large amounts of gas or air (6 to 8 liters) as used by Carelli, however, are dangerous and are entirely unnecessary for diagnostic purposes.

Our experience with pneumoperitoneum at Michael Reese Hospital began in 1923, and our first report (14), published in this journal in the January issue of 1926, described its use in 150 patients. In October of that year we published a preliminary report on the combined use of iodized

oil instillation and pneumoperitoneum, and have since then reported a satisfactory experience with this modification in a large number of patients.

During the development of our present technique, we devised a self-retaining instrument (15) (Fig. 1) to facilitate the performance of the Rubin patency test, for oil instillation, and transuterine pneumoperitoneum. This instrument has since proved entirely satisfactory. In addition to the modified Graves' speculum used in the set we now have added a "side-opening" speculum (Fig. 2) which may be removed without disturbing the self-retaining cannula. The purpose of this is to eliminate the shadow of the speculum on the roentgen film which occasionally obscures some portion of the pelvic picture if the speculum is retained while the roentgenograms are taken.

Our early attempts with pneumoperitoneum were rather awkward, as it was difficult to maintain the patient in a knee-chest posture and still use a Potter-Bucky diaphragm close to the patient's abdomen. This led to the development of a suitable roentgenographic table (16) which we described in the *American Journal of Obstetrics and Gynecology* in 1929 (Fig. 3). With the above armamentarium and the addition of a simple volumeter which is used with carbon dioxide for tubal patency tests, we have continued to use both the simple pneumoroentgenography and the combined iodized-oil (lipiodol) instillation and pneumoperitoneum in well over one thousand cases.

All of the members of the gynecological department of Michael Reese Hospital are entirely familiar with the methods, and in co-operation with the roentgenologist, Dr. R. A. Arens, make frequent use of them. As we have previously stated, these are not routine methods of examination, but are useful in establishing a correct pre-operative diagnosis in many puzzling cases. The differences in opinion which frequently arise in diagnosis on a gynecological service are commonly settled in our group by satisfactory pelvic roentgenograms rather than by an exploratory operation. Furthermore, our internes and the students who come to us as clinical clerks appreciate the great teaching advantage of such lucid pelvic visualization and they frequently inquire why greater emphasis is not placed upon it in the medical schools. Their increasing interest in a diagnostic procedure which is so impressive and valuable will doubtless result in its adoption by all teaching institutions where it is not now being utilized.

CONTRA-INDICATIONS

The following conditions contra-indicate the *transuterine route* with either gas or iodized oil for the patency test, abdominal inflation, or utero-salpingography! (1) pregnancy—apparent or suspected; (2) bleeding from the uterus; (3) purulent discharge from the cervix or vagina; (4) acute or subacute pelvic or abdominal inflammation; (5) pelvic tumor or mass completely filling the true pelvis, or a swelling 5 inches or more in diameter.

For the *transabdominal route* of inflation the first three conditions listed above are not contra-indicated, but the two latter hold for either method. In addition, the age and general condition of the patient shall be considered. We have used transabdominal pneumoperitoneum in girls from 13 to 16 years of age with satisfactory results. On the other hand, we have avoided its use in elderly women, those with cardiac and pulmonary disease and patients at any age who were debilitated.

While not directly contra-indicated, pelvic visualization is not needed when the ordinary clinical means of diagnosis prove sufficient. However, in case of medico-legal issue the pre-operative roentgen evidence may be of great value.

PREPARATION OF THE PATIENT

In order to obtain the most satisfactory results, hospitalization for 24 hours is desirable. While this is not absolutely essential, it serves to minimize the discomfort caused by the abdominal inflation and allows time for a series of films to be taken over an extended period in order to reach a decision in cases of questionable tubal obstructions. It is desired that the lower bowels and bladder are empty at the time the films are made, therefore a soap-suds enema is routinely administered about 1½ hours before examination, and the patient is urged to void the urine immediately before going to the X-ray room. About three-quarters of an hour before the examination, the patient is given by hypodermic injection 1/6 grain of morphine sulphate and 1/150 grain of scopolamine, and is kept in a quiet, darkened room with her eyes covered. She is transported to the X-ray department on a cart and is assisted to the table with as little disturbance as possible. By this means many patients doze throughout the procedure and are free from any marked discomfort. There are always some patients who do not respond to the analgesic-hypnotic dose, but even in these women the discomfort of peritoneal distention is not great or prolonged beyond a few minutes.

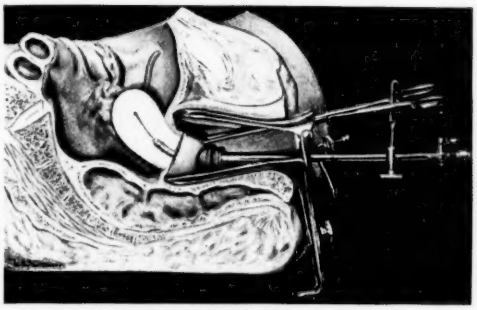

Fig. 1. Author's self-retaining cannula, *in situ*, for iodized oil instillation, patency test or transuterine inflation.

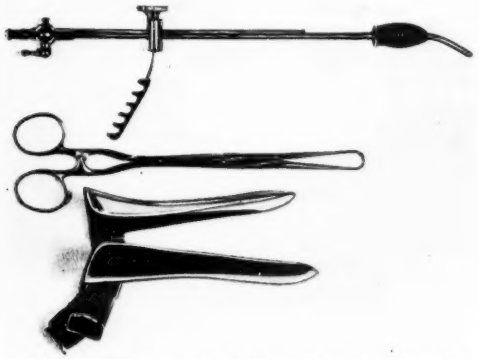

Fig. 2. Cannula set with a side-opening speculum which may be removed before roentgenography.

PROCEDURE

The patient is first placed in the dorsal position with the knees drawn up and separated. A roll pad is placed under the buttocks (Fig 4). The sterile bivalve speculum is inserted into the vagina and spread so that the cervix is exposed. The vagina and cervix are then coated with a 2 per cent aqueous solution of mercurochrome (preferable to tincture of iodine because it does not burn and does not obscure the cervix), and the anterior lip of the cervix is grasped with the short tenaculum. The length and direction of the cervical canal are determined by means of a sterile uterine sound. Upon this information depends the choice of cannula (long or short tip) and the relation of the vertical spring to the cannula curve (Figs. 5A and 5B). A small wire track along the cannula shank prevents the vertical spring from rotating about its axis. When the cannula is in place with the soft rubber acorn against the external os, the tenaculum lock is engaged in the vertical spring, and by adjusting the latter the cannula becomes self-retaining. The speculum may now be removed if desirable.

The tubal patency test may now be carried out by the usual technique, care being taken to permit the gas to flow very slowly and not exceeding 200 millimeters of pressure. If patency obtains, a a liter of carbon dioxide is introduced into the abdomen by this means. If obstruction is apparent, the abdomen is prepared with alcohol-mercurochrome solution and a peritoneal puncture is made with a modified (rigid) lumbar puncture needle through the left rectus muscle, about 1 inch below the level of the umbilicus and 1 to 2 inches to the left of the median line. The needle is held perpendicular to the skin surface and with steady finger pressure three distinct layers of resistance are met. The first and greatest is the skin itself. After this has been passed the needle point advances readily until the fascia is reached when again slightly increased pressure is required. A little beyond a less resistant but distinctly painful layer, the peritoneum, is punctured by a short, quick thrust. The pain is only momentary and is a good indication that the needle point is intraperitoneal. The tube from the volumeter is then attached to the adapter on the needle handle and the inflation is readily made. One may use a greater rate of flow of the gas through the puncture needle than with the transuterine route, the pressure in the manometer remaining at a low level, and the amount of gas used is measured by the number of oscillations of the volumeter. We use a 25 cubic centimeters volumeter for this purpose and usually count 40 oscillations for abdominal inflation. Small or thin subjects may require less than 1 liter of gas, but few if any require more. Immediate withdrawal of the needle after in-

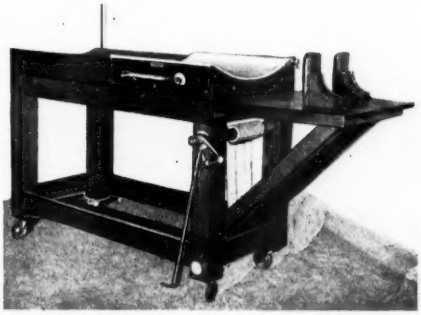

Fig. 3. Author's radiographic table suitable for obtaining pelvic roentgenograms with the patient in the partial knee-chest position.

Fig. 4. Patient in dorsal posture on table for patency test, lipiodol instillation, or transuterine inflation.

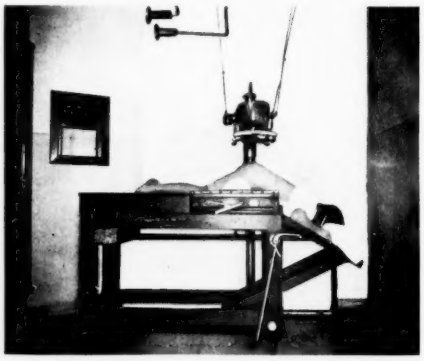

Fig. 6. Patient in correct modified knee-chest position on radiographic table for pelvic pneumoroentgenography.

flation prevents escape of the gas from the abdomen. Carbon dioxide absorbs rapidly so that it is not necessary to "deflate" the abdomen after the films have been made.

Where it is desirable to utilize pneumoperitoneum in diagnosis, the patient is assisted in turning about to assume the knee-chest position, care being taken to keep the head and shoulders lower than the hips. This permits the gas to accumulate about the pelvic viscera, and the abdominal organs to fall toward the diaphragm. Manipulation of the abdomen is useful in "shaking" the intestines out of the pelvis. The patient's shoulders are next adjusted against the shoulder rests with her arms extended over the head, and the movable end of the table is lowered to a suitable degree. The thighs, meanwhile have been elevated upon the pad that previously supported the buttocks, the knees slightly bent, and the back in lumbar lordosis, thus maintaining the patient in a modified and tilted knee-chest posture (Fig. 6). This position has been found most suitable for pelvic roentgenography. Stereoscopic and direct films are now made—usually three films are taken.

If iodized oil (lipiodol, iodipin, etc.) is to be used in combination with pneumoperitoneum, the instillation may be made before or after turning the patient from the dorsal to the prone posture. Frequently 3 cubic centimeters of lipiodol is instilled into the uterus with the patient in dorsal posture and one film is taken, after which the patient is turned in the desired posture and then an additional 2 cubic centimeters of the oil is injected, provided there is no resistance to the flow. If any obstruction is met, *no force is used.* The injection is stopped and the films are made as with simple pneumoperitoneum. A 10 or 20 cubic centimeter Luer syringe is adequate in experienced hands for the instillation of iodized oil. For the inexperienced, manometric control is advisable (Jarcho).

The patient is left in this position for a few minutes while the first set of films is being developed and interpreted. If there is evidence of obstruction to one or both fallopian tubes, a series of films is made to determine whether the obstruction is functional (spasm) or is pathological. Sometimes an additional 1 or 2 cubic centimeters

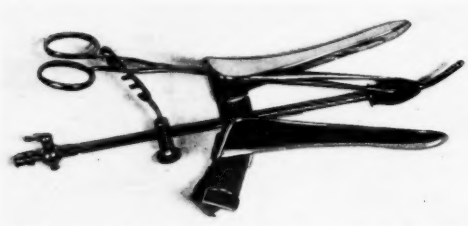

Fig. 5A. Self-retaining cannula adjusted for anteverted uterus.

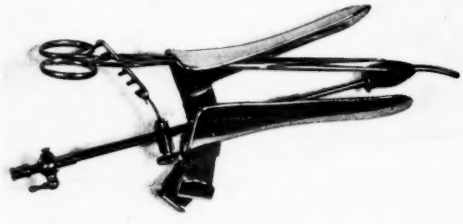

Fig. 5B. Self-retaining cannula adjusted for retroverted or retroflexed uterus.

Fig. 7A. Incorrect and correct technique of pelvic visualization. Lipiodol alone was used and films taken immediately. Result not diagnostic.

Fig. 7B. Combined pneumoperitoneum and lipiodol instillation: films diagnostic of right tubal mass resembling ectopic pregnancy. (Hæmatosalpinx found.)

of lipiodol is added, but only in case the oil flows easily. Additional films are made in half an hour, 1 and 2 hours, the instrument having been removed meanwhile, and if they do not definitely show intraperitoneal spill, films are taken after 18 to 24 hours. Only in this manner may one avoid false conclusions regarding tubal nonpatency and the location of tubal obstruction (Figs. 7A and 7B).

After the first series of films have been taken, the patient is assisted in rolling back on to the cart (without a pillow) and is lifted or helped into bed. By remaining flat or with the hips slightly elevated for a few hours shoulder pain can be entirely avoided, and when patient remains in the hospital over night, all of the gas has been absorbed. There is rarely any complaint of discomfort.

Fig. 8. Uterine sinuses and pelvic veins containing lipiodol after uterine injection. Although no harm resulted such errors may be avoided by careful technique.

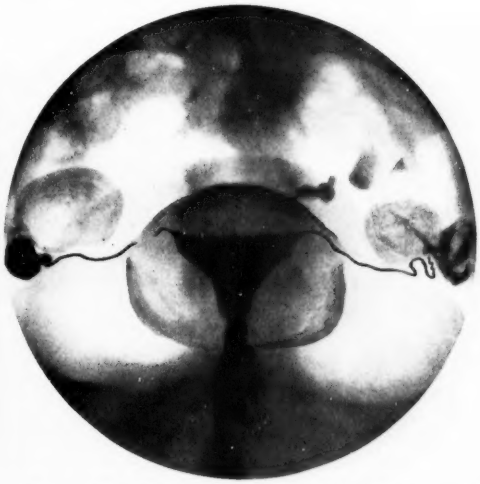

Fig. 9. Visualization of the pelvic viscera by means of combined uterosalpingography and pneumoperitoneum. (Author's method.)

There have been a few reports in the literature of long retention of lipiodol (Lash, 7; Ries, 11). Our observations (17) indicate that ordinarily all the lipiodol is absorbed from the free peritoneal cavity in about 2 weeks. When injected into a closed cavity, such as an hydrosalpinx or into a serous cyst enveloping the fimbriated end of the tube, one might expect lipiodol to remain unabsorbed for an indefinite time. Apparently no harm is done by long retention of lipiodol (Forestier).

Fortunately, lipiodol is harmless even when injected into the blood stream, and intravenous injections have been utilized for roentgen visualization. In rare cases lipiodol has been injected into the uterus and has promptly filled the uterine sinuses and has been found ascending the pelvic veins (Fig. 8). Even though no harm resulted from such injections, undue pressure in an apparently obstructed utero-tubal canal is to be avoided. A judicious selection of patients, after consideration of the menstrual history, and a careful general and pelvic examination, and a deliberate and painstaking technique are essential to obtain satisfactory diagnostic roentgenograms (Fig. 9).

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WIRE TRACTION IN FRACTURES OF THE LOWER EXTREMITY

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THE end-results in fractures of the lower extremity, particularly in fractures of the femur, frequently leave much to be desired from the standpoint of functional restoration. Consequently any method of treatment which offers an improvement in end-results and which is at the same time relatively simple and easy of application, merits serious consideration.

Such a method is skeletal traction, applied by means of the Kirschner wire. In this paper, I wish to show the excellent results which may be obtained in the great majority of cases without open operation, with ease and comfort to both physician and patient, and to urge that those surgeons having much to do with fractures familiarize themselves with the method and utilize it in proper cases. The results to be obtained will be a source of great gratification to all concerned.

The principle of skeletal traction in the treatment of fractures is not new, but the methods of applying it have undergone many changes. Space will not permit a review of the historical field, although this contains much of interest. Briefly, it may be said that skeletal traction was first put upon a practical basis when Steinmann proposed the method which is now known by his name, and which he first demonstrated in June, 1907, before the medical society of Bern. Although he was by no means the first to use the perforating nail for purposes of traction and extension, he so simplified the procedure as to render it widely applicable and generally successful when properly carried out in those cases in which it is indicated.

It is of interest to note that his method when originally proposed was met with a storm of opposition and criticism, which has not entirely subsided at the present day. This opposition, then as now, arose from those unfamiliar with the method and its possibilities, and the objections were based chiefly upon the danger of infection.

ADVANTAGES OF SKELETAL TRACTION

In all cases in which continued weight extension is necessary, properly applied skeletal traction offers many advantages over the methods commonly employed. Briefly summarized, the outstanding ones are as follows:

1. Since traction is direct, none of it being taken up by the intermediate soft parts, much less weight is required to effect reduction and overcome shortening.

2. Traction is regular and continuous, which it must be to be effective.

3. Properly applied, the method is entirely painless, and the patient is comfortable throughout the entire course of treatment.

4. Any degree of shortening can be readily overcome.

5. The lower fragment is at all times under excellent control, and can readily be brought into line with the upper one.

6. For the application of traction, two circumscribed points only are necessary.

7. Since this leaves the rest of the leg entirely free, especially in fractures of the femur, active and passive motions may be readily performed at the knee and ankle; these joints, therefore, remain in excellent condition, and there is very little stiffness to be overcome at the conclusion of the treatment.

8. The end-results are so uniformly satisfactory that open operation can be avoided in the great majority of cases.

The chief objection which can be urged against the employment of skeletal traction is, of course, that there exists the danger of infection. Certainly with improper and careless technique, infection can occur; but this is also true of any surgical procedure. On the other hand, with the rigidly aseptic technique which should always be employed, just as certainly infection can be avoided. This is especially true when a fine piano wire, such as that recommended by Kirschner, is used. Under these conditions, the danger of infection is practically non-existent. Such a categorical statement cannot be made, however, in regard to ice tongs or calipers, or to the Steinmann nail. In the use of both of the last-named instruments infection is much more likely to occur, in spite of all precautions. Both the ice tongs and the Steinmann nail produce much more tissue damage than does the wire; in addition, the tongs have a tendency to slip and to produce skin necrosis, and the nail not infrequently becomes loose after a few days, and may slip sidewise. These things may occur, no matter how rigorous the technique in the application of the traction, and any one of them definitely increases the hazard of infection. Consequently, the use of ice tongs or nail is not advisable as a routine measure. The case is entirely different, however, as regards the Kirschner wire.

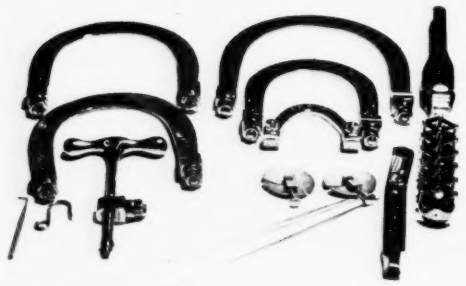

Fig. 1. Kirschner apparatus for application of skeletal traction, showing extension holder, traction bows, wires, and wire tightener, as described in text.

Other objections to skeletal traction are of comparatively little importance. At first sight, the procedure would appear to be a very heroic one; as a matter of fact, through and through skeletal traction is absolutely painless. It has been argued that important structures may be injured by the passage of a perforating nail or wire; such a danger does not exist if the operator possesses the proper anatomical knowledge. Finally, it has been asserted that delayed union is more frequent following the use of skeletal traction. This depends entirely upon a proper approximation of the fragment ends: if they are in good contact, union will occur with normal rapidity; on the other hand, if there is a diastasis of the ends, union will probably be delayed, and may be absent. This, however, simply emphasizes the necessity for frequent observation by means of the X-ray until the exact amount of weight necessary is found.

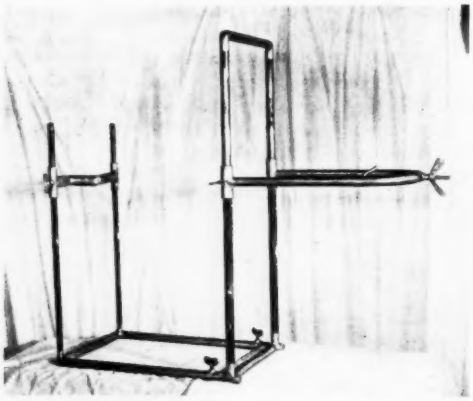

Fig. 3. Screw extension apparatus of Boehler.

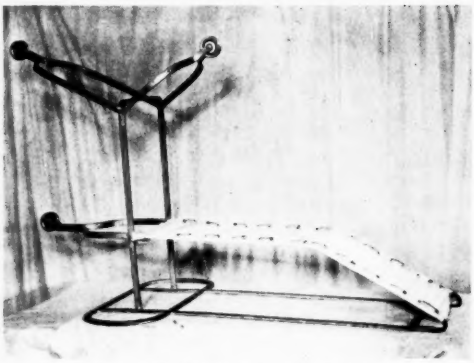

Fig. 2. Boehler splint ready for use.

INSTRUMENTS

Substitution of the perforating nail by a fine steel wire is the latest link in the long chain of technical procedures for the treatment of fractures. Theoretically and practically, it represents one of the greatest advances of recent years in this field. Traction by means of a perforating steel wire possesses all of the advantages of skeletal traction in general, and in addition, has some of its own. Since the wire is drill-pointed, it is much easier to put through the bone than the steel pin, which must be driven through by means of a hammer or mallet. Because of the fineness of the wire, it occasions very little change in the bone structure, and on this account may be left in place for much longer periods than the pin, and finally, again because of the small size of the wire, any possible danger of infection is reduced to a minimum.

Various ways have been suggested for putting the wire through the bone and for applying traction; the apparatus of Kirschner is one of the simplest, and is the one with which I am familiar.

All of the instruments necessary for the application of the traction are illustrated in Figure 1. They comprise the various sizes of steel piano wire, a special so-called "accordion" holder for the wire during insertion, steel bows or horse shoes of various sizes, and a special device for tightening or stretching the wire in the bow, so that it will not bend. In addition to these, a Braun splint or one of its modifications is required (Fig. 2). For fractures below the knee, a special traction apparatus for holding the leg in extension during the application of the cast is also a convenience and an advantage, but it is not a necessity (Fig. 3).

With this equipment, practically any fracture, open or closed, of the long bones of the lower

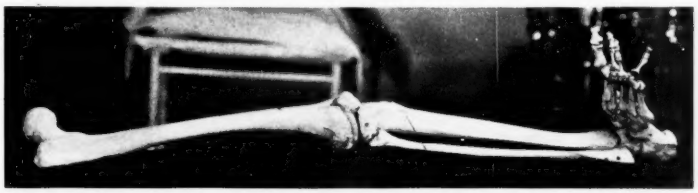

Fig. 4. Various points for application of wire traction, viz., above femoral condyles, through tibial tuberosity, and through os calcis.

extremity can be satisfactorily treated, and an excellent functional result secured without any operation more formidable than that required for the insertion of the wire. It should be clearly understood that I am excluding from this discussion fractures of the femoral neck: these constitute a separate class, and while skeletal traction may sometimes be employed with advantage in certain cases, it is by no means indicated in the great majority of such fractures; consequently, they do not here enter into consideration. But to all other fractures of the shafts of the long bones which require traction, this method is applicable.

TECHNIQUE

Before the traction is applied, the bed is first of all prepared by placing several boards crosswise beneath the spring, to prevent localized sagging when the splint with the traction weight rests upon it. The foot of the bed is also elevated, so that the body may act as a counterweight. If traction pulleys are not incorporated in the splint, it will also be necessary to have an overhead frame, or other pulley support at the foot of the bed.

Fractures of the femur. In fractures of the femur, the wire may be put through the bone just above the condyles, or through the tuberosity of the tibia, the choice of location depending largely upon the situation of the fracture and attendant injuries of the soft parts. In the case of a fracture of the condyles themselves or one immediately above them, or in the case of an infected wound or of great destruction of tissue in the immediate vicinity, or if putting the wire through the bone involves traversing the fracture hæmatoma, it is clearly obvious that another location should be chosen. This alternate location is the tibial tuberosity just below the attachment of the patellar ligament (Fig. 4).

The application of traction above the condyles is the procedure of choice. It possesses two distinct advantages: direct control of the lower fragment is assured, and the traction may be safely left on for much longer periods than when it is applied through the tibial tuberosity. In the latter position, all the traction is necessarily transmitted through the knee joint and its component structures; some authorities feel that this does no harm, and statements to this effect may be found in the literature. It is argued that the knee joint itself, particularly its capsule, is but comparatively little affected by the traction, and that the effect of the pull is really exerted upon the thigh muscles which insert below the knee. This is undoubtedly true for relatively short periods of traction; but if continued too long, eventually the capsule will feel the strain. Four weeks would appear to be a safe limit; no harm will be done to the knee joint in this period, but at the end of it, some form of indirect traction should be substituted for the wire. By this time, some callus will have formed, and the substitution may be fairly easily carried out.

The wire is put through the bone under the strictest aseptic precautions. This is one step in the procedure which admits of no compromise. In my work, the patient is always taken to the operating room, and the field is prepared as for a major operation. Thorough scrubbing on the part of the operator, and the use of sterile gown and gloves are never omitted. A light gas anæsthetic is all that is necessary. After the wire is in place,

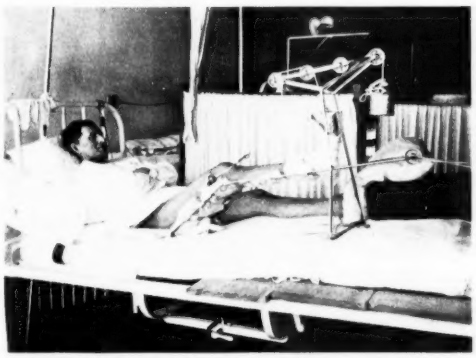

Fig. 5. Treatment of fracture of femoral shaft.

Fig. 6. Fig. 7. Fig. 8.

Fig. 6. Fracture of femoral shaft before application of traction.
Fig. 7. Fracture of femoral shaft 24 hours after application of traction; separation of fragment ends clearly visible, showing that amount of weight is excessive.
Fig. 8. Same fracture as shown in Figure 6, after weight has been decreased from 20 to 14 pounds.

the extension holder is removed and pledgets of sterile gauze are pushed over the protruding ends, being sealed to the skin with collodion; a few turns of bandage are also used to hold these pledgets more securely in place. Following this, a sufficient number of perforated felt discs snugly, but not tightly, to fill the space between the traction bow and the skin are slipped over each end of the wire. These effectually prevent side-slip, and at the same time do not cause undue pressure on the skin. The traction bow is then applied to the wire, and the latter is tightened by means of the special device, the ends of the wire are cut off close to the bow, and the patient is ready to be placed in bed on the splint. The traction bow selected must be somewhat larger than the leg, so that a definite space exists on each side between the ends of the bow and the skin. This is highly important; if the ends of the bow come in contact with the skin, pressure sores will invariably be produced, greatly increasing the risk of infection, and rendering the removal of the traction necessary.

The position of the leg on the splint is such that the bend of the splint corresponds to the bend of the knee; thus there is partial flexion at both hip and knee. For the purpose of preventing foot-drop and outward rotation of the leg, adhesive plaster strips with a spreader and cord are then applied to the dorsal and plantar surfaces of the foot, the cord being fastened to the splint or to the overhead frame by means of a pulley and a very light weight; thus the patient is at all times able freely to exercise the ankle. The necessary weight for traction is then attached to the bow by means of a light cord, and a block of wood or empty box of suitable height is placed at the sound foot of the patient: upon this he "stands," so to speak, being thus prevented from gradually slipping toward the foot of the bed. In this way, a constant traction is at all times maintained.

The patient so treated is immediately comfortable (Figure 5). Whenever he desires, he may make use of a back rest; by means of a hand grip suspended from the overhead bar on the frame, he is able to raise himself for the necessary care of the skin of his back and buttocks, and for use of the bed pan.

When skeletal traction is used, the amount of weight necessary to effect reduction is decidedly less than that required when methods of indirect traction are used. In fractures of the femur, it is rarely necessary to use more than 25 pounds in the beginning, and usually 20 pounds or less are

sufficient. After reduction has taken place, in my experience, 12 to 15 pounds are all that is needed to maintain it. If more weight seems indicated, however, no hesitation need be felt about applying it, as the wire and other portions of the apparatus will sustain much greater weights than indicated, and the patient will be entirely comfortable. Under such circumstances, considerable elevation of the foot of the bed will be necessary, in order to obtain sufficient additional countertraction from the body weight.

The weight necessary to produce adequate traction should be estimated by taking into consideration the age, weight, sex, muscular development, and general physical condition of the patient. This amount should be applied at the beginning of the treatment and decreased as indicated; it is a mistake to start with a light weight and increase it. With sufficient traction, reduction of deformity and correction of shortening usually take place within 24 hours; as a matter of fact, it is very easy to overcorrect and produce lengthening (Figs. 6 and 7). For this reason, during the first few days, until satisfactory position of the fragments is assured, frequent X-ray observations are necessary. If lengthening has occurred, naturally the weight must be reduced until the fragments are in contact (Fig. 8). When this has taken place, with proper daily inspection of the apparatus, the correction and reduction will be maintained, and further X-rays will be necessary only for the purpose of ascertaining the progress of callus formation. Comparative daily measurements of the length of the legs are made by having the uninjured extremity held in approximately the same position as the fractured one, after which the distance is determined between the anterior superior spine of the ilium and the inferior border of the patella.

For satisfactory healing, apposition of the fragment ends is essential. This is particularly the case in transverse fractures of the femur. While it is true that a small gap between the ends will usually be bridged by callus, nevertheless, bony union is delayed; a large gap between the ends may give rise to nonunion. For this reason, it must be emphasized that after the shortening has been overcome, careful observations and adjustments of the weight are necessary until the exact amount is found which will maintain the reduction without separation of the fragments.

In fractures of the femur, the position of the Braun splint in the bed, and consequently of the leg, is a matter of some importance. The time honored rule in the treatment of fractures is to bring the fragment over which we have control into line with that one whose displacement cannot be influenced, in this case, the upper fragment. This can be done only by varying the position of the splint. In fractures high up in the femur, the upper fragment is strongly abducted, as a rule; consequently, the splint must be placed in a position of extreme abduction, thus lying somewhat diagonally across the bed. In some cases, it may be necessary to arrange a support for the lower and outer portion of the splint outside the bed. This strongly abducted position decreases if the fracture is lower down the shaft of the bone, and in fractures of the middle and below, the splint lies in the axis of the bed. The exact position, of course, is determined by means of the X-ray.

In fractures of the femur, the duration of the skeletal traction depends entirely upon the point of application. If the wire has been inserted in the region of the condyles, I have no hesitation in continuing the traction for 8 to 10 weeks, or so long as is necessary. I have seen no bad results whatever; the wire shows no tendency to cut through the bone, or even to loosen to any appreciable extent. For reasons which have been given, the situation is otherwise when the traction is made from the tuberosity of the tibia. Under these circumstances, direct traction must be replaced by some other form at the end of 3 or 4 weeks. By this time, sufficient callus will have formed in the average case to prevent displacement of the ends of the fragments during the manipulations incident to changing the traction.

As a substitute for the wire, indirect traction by means of adhesive plaster will probably be found to be more generally satisfactory. My own preference is for the zinc-oxide gelatin paste dressing as used by Boehler. Properly applied, it is more comfortable and more secure; functional treatment can also be more readily carried out. However, a certain amount of experience is necessary for its application, and if one has not this experience, it is better to depend upon adhesive plaster. The chief disadvantages of this form of traction are its tendency to slip, and the blistering of the skin produced if the plaster is not smoothly applied or if the pull is unequal. However, with the slight change in the weight distribution presently to be described, these disadvantages are almost completely obviated.

In applying the adhesive traction, strips should be placed both on the thigh and on the leg below the knee, the latter strips being attached to a spreader distal to the sole of the foot. Half of the necessary amount of weight is then attached to the thigh strips and the remaining half to those

on the lower leg. As stated, such a distribution practically overcomes any tendency to blistering and slipping. During all the procedures involved in making these changes, the wire traction remains active, being released only when the indirect traction is ready to receive the weight. The wire is then removed. When it is desired to exercise the knee, the weight attached to the lower leg is hung temporarily upon the thigh extension, later being again replaced on the lower leg.

Fractures below the knee. In treating shaft fractures of the bones below the knee, the same general principles apply. The method is one which gives particularly gratifying results in spiral fractures of the tibia, which are notoriously difficult to retain, even if reduction can be accomplished by ordinary methods, and which consequently are treated by open operation.

The wire is inserted through the os calcis at a point approximately a thumb's breadth below and posterior to the external malleolus (Fig. 4). The leg is then placed upon the splint, the foot suspended as usual, and the traction weight applied. In preparing the splint for a fracture below the knee, one detail is very important and must not be overlooked. In applying the supporting bandage, it should be drawn tightly over the thigh portion of the splint, and for one or two turns below the bend of the knee; in the region of the calf, however, it should be applied somewhat more loosely to allow for the bulge of the calf muscles, the final turns in the ankle region being again tightly drawn. If this is not done, an anterior displacement of the lower fragment will occur which is almost impossible to overcome. In these fractures, the splint lies in the bed axis. The amount of weight necessary for reduction rarely exceeds 10 to 12 pounds; thus moderate elevation of the foot of the bed is all that is required. In the lower leg fractures, not infrequently lateral displacements are seen which are not entirely overcome by the longitudinal traction; in such cases, lateral traction is easily applied by means of a broad sling about the leg, and will usually overcome the displacement. Occasionally it may be necessary to oppose the lateral traction on one fragment by similar traction on the other, but in the opposite direction. If under these circumstances, reduction is not readily accomplished, it is entirely likely that there is tissue interposition, and the case must be treated by open operation.

Excellent results in fractures of the lower leg are obtainable by the method just described. However, if the necessary equipment is available, the method of Boehler offers some advantages. To apply it properly, a screw extension apparatus is necessary (Fig. 3). The wire is inserted through the os calcis as usual, and the traction bow applied with the wire under proper tension. The leg is then placed in the apparatus with the knee flexed to a right angle, the traction bow is attached to the screw, and sufficient traction is applied by means of the screw to effect reduction. An unpadded circular plaster cast is then applied, incorporating the wire. As soon as the plaster has hardened, the screw traction is released, the leg is laid on the splint, and the necessary weight is applied. Immediately thereafter, the circular cast is split longitudinally over the anterior aspect of the leg, a proceeding which must under no circumstances be omitted. The foot is suspended to prevent axial rotation of the leg. The fractured leg is thus held much more securely than with simple traction, and movements of the patient are unable to disarrange the position of the fragments.

FUNCTIONAL AND AMBULATORY TREATMENT

The ease with which functional treatment may be carried out in fractures of the femur constitutes one of the principal advantages of the method. The patient is able to exercise the foot and ankle from the first day. After the apparatus has been satisfactorily adjusted, and he has become accustomed to it, which is usually by the end of the first week, passive motions of the knee may be begun. For this purpose, the cord which suspends the foot is passed through a pulley on the overhead frame or on the splint, and the end is held by the patient. The cross slings supporting the lower leg are now removed, and the patient is able to raise and lower the foot until it rests on the bed, thus exercising the knee joint and muscles of the thigh. After exercise, the cross slings are replaced, and the foot again suspended as before. At first this may be done for a 15 minute period morning and evening. Later, the periods may be lengthened, and an additional one added. In the beginning, also, the amplitude of motion should be slight, gradually increasing as time goes on. As the callus becomes firmer, the purely passive movements should be supplemented by active contractions of the thigh muscles; toward the end of the treatment in bed, it will be found that most patients can flex and extend the leg at the knee with but very little assistance from the cord attached to the foot.

By the end of 10 to 12 weeks, in most cases, and sometimes sooner, the callus is sufficiently firm and union is so far advanced that ambulatory treatment may be begun. The time for this is determined by careful clinical and X-ray studies of the site of the fracture.

When it is decided to begin the ambulatory treatment, the weights, traction bow, and wire through the bone are removed. Removal of the latter is a very simple procedure, but here again, strict asepsis is necessary. After removal of the traction bow, by means of a sterile wire-cutting pliers one of the protruding ends of the wire is cut off close to the skin; the short end and surrounding skin is then liberally painted with iodine, the wire seized with forceps on the other side, and withdrawn. The small puncture wounds remaining are painted with iodine, and a sterile dressing applied, which remains in place for a few days. No further attention is required and in my experience, none of these wounds has failed to heal immediately.

In the ambulatory treatment of fractures of the femur, the Thomas knee splint has given me great satisfaction and excellent results. It is simple to apply and very efficient. A supply of Thomas thigh rings of various sizes is kept on hand, and the correct size for the patient is determined by fitting it upon him; the splint is then made up in conformity with the proper measurements of length so that in the erect position, the sole of the patient's foot is one-fourth of an inch above the inner sole of the shoe; all the weight is thus transmitted to the tuber ischii. The sole of the opposite shoe is elevated to correspond. This splint is worn until union is firm, and there is no longer any danger of bending at the fracture site. This usually requires 6 weeks to 2 months; with badly comminuted fractures it frequently takes even longer.

In fractures of the leg below the knee, traction for a period of 3 to 4 weeks is usually sufficient. By this time, a fairly strong callus will be present in the average case, and the traction may be replaced by a cast. In my work, an unpadded cast is applied with a walking iron below the sole of the foot, and the ambulant treatment is begun immediately. The majority of patients learn to walk surprisingly well within a few days. For the first day or two, they are allowed to use crutches, but as soon as possible these are discarded for a cane, and many patients will even dispense with this. This so-called functional treatment undoubtedly shortens the period of disability; when the cast is removed, there is no joint stiffness to be overcome, and the muscles are in excellent condition. However, experience in the application and use of unpadded casts is necessary to avoid pressure sores and other troublesome sequelæ; and, if one has not this experience, it is better to rely on the cast as ordinarily applied. Such knowledge and experience are readily acquired, however, and are well worth the time and trouble spent in acquiring them.

The cast remains in place for from 4 to 6 weeks, by which time union is sufficiently firm to allow it to be dispensed with. If, upon its removal, the callus is still painful upon weight bearing, bony union is not yet strong enough, and another cast should be applied for a couple of weeks more. After removal of the cast and the beginning of active use, the usual evening swelling of the lower leg and ankle occurs, but is much less marked if ambulatory treatment has been employed. It may be obviated almost altogether by the application of a zinc gelatin paste cast from the toes to just below the knee, immediately following removal of the cast. Patients find this very comfortable, and the moderate, non-rigid support which it gives encourages confidence in their ability to use the injured extremities. Such a cast may be worn for 2 or 3 months, but during this period will require changing several times.

RESULTS

During the past 2 years, my records show that I have used this method of skeletal traction in 30 cases of fracture of the femur, and in 36 cases of fracture of the tibia or of both bones of the leg below the knee. Formerly, a number of these cases, particularly the spiral fractures of the tibia, would have been operated upon, because otherwise, satisfactory reduction and retention would have been impossible. By means of wire traction, all open operations with their attendant risk of infection and prolonged healing period, have been avoided. The end-results, everything considered, are much better than could have been obtained by any other means. Particularly is this true of fractures of the femur. And these results have been secured with much greater comparative comfort to the patients. These statements must not be taken to mean that open operations are never necessary in fractures of the lower extremity; in certain cases they are unavoidable. What I wish to emphasize is the fact that the intelligent use of skeletal traction, applied by means of the Kirschner wire, will greatly reduce the number of cases requiring operation, and that the results obtained in all cases treated conservatively will be as good as those obtained by any other procedure now commonly employed, and in most cases even better.

From my experience, I am convinced that the length of time which is required for functional restoration is definitely less when this method of treatment is employed. To obtain evidence upon this point, a comparative statistical study was

attempted, but was abandoned because of incompleteness of earlier records. This decrease in length of disability is to be attributed entirely to the excellent condition in which the neighboring joints and muscles may be maintained during the period of consolidation of the fracture, in cases of fracture of the femur by active exercise, and in cases of fracture below the knee by the use of the ambulatory cast. That a condition approximating normal is present is proved conclusively to my mind by means of the X-ray. This shows that the bone atrophy which is almost invariably present in cases which have been submitted to prolonged immobilization is conspicuous by its absence if "functional" treatment has been carried out as described.

For success with this method, close attention to essential details is important. This necessitates frequent thorough inspection, particularly in the beginning of the treatment. After a few days, with a little explanation, the average patient has grasped the underlying principles and readily co-operates by himself seeing to it that the traction is at all times active, that the splint remains in the proper position, etc. A single daily inspection is then all that is necessary.

In conclusion, it must be emphasized that this is not a method to be employed by the man who treats only occasional fractures; hospital facilities and surgical experience are indispensable for success. But to those surgeons, particularly industrial surgeons, who are doing considerable fracture work, and who are conscientiously interested in improving the treatment of fractures in general and in securing better end-results, the method can be most highly recommended.

THYROTOXICOSIS IN THE NEGRO

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From the Department of Surgery of Western Reserve University School of Medicine and the Lakeside Hospital, Cleveland

IT is commonly held that thyrotoxicosis is an extremely rare disease in the negro, yet a review of the patients admitted to the Lakeside Hospital because of "goiter" has shown a relatively large number of negroes with a severe form of that disease syndrome. We have been especially interested in studying the variations of this syndrome in a race that is supposed to possess some natural immunity to the more severe forms of thyrotoxicosis. It is quite probable that many of the milder forms pass unrecognized while the severer forms, the type with which we deal in this paper, can hardly be confused with any other clinical picture of disease. It is well known that thyrotoxicosis is most frequently found in people of a high strung temperament; consequently the discovery of this symptom complex in the negro has prompted us to study the train of affairs that seems to precipitate such a disturbance in that race. Bram states that thyrotoxicosis is most prevalent in the Caucasians, particularly among the Hebrews, the Irish, and the Latinic peoples. Mongolians are next in order of degree of susceptibility, the negro being relatively immune.

The problem of the frequency of colloid goiter in the negro has been extensively studied by Cohen, Goldberger and Aldinger, and Mustard and Waring, and their results agree with those of Olesen who found in Cincinnati and again in Colorado that there was no evidence of racial immunity to simple goiter in the colored race. Bram also states that in spite of the fact that simple goiter is more common among the negroes, hyperthyroidism is rarely if ever found in that race.

REVIEW OF LITERATURE

Jones reported 18 negroes with goiter out of a total of 407 patients from his private practice in Georgia, a territory in which the population of the white people is somewhat larger than that of the colored people. Six of the 18 colored patients had true exophthalmic goiter, one had "toxic non-exophthalmic goiter with chronic cardiac symptoms" and the rest had non-toxic adenomata of the thyroid gland. He states that he is of the opinion that goiter is less common in the negro than among white people.

Harris states that during the year 1926 there were admitted to the Shreveport Charity Hospital 5,583 patients of whom 6 were cases of goiter. Grouped according to sex and race there were 2 white females, 3 negro females, and 1 negro male. In the year 1927, a total of 7,467 patients were admitted and of this number 19 had goiter. Grouped according to sex and race, there were 7 white females, 2 white males, and 12 negro females. Of the total number of patients with goiter admitted during the 2 years, there were 9 with exophthalmic goiter, 4 with toxic adenomatous goiter, 10 with colloid goiter, and 2 with non-toxic adenoma of the thyroid gland.

REPORT OF CASES

During the 5 years between July, 1924, and July, 1929, there were 7,421 patients admitted to the Surgical Service of the Lakeside Hospital. Of these patients, 729 had goiter and of this number 571 showed the classical signs of thyrotoxicosis, 358 being classified as having exophthalmic goiter and 213 as having toxic adenomatous goiter. Of the 358 patients with exophthalmic goiter, there were 325 white people and 33 negroes, 12 negro males and 21 negro females. Five negro females and 1 negro male had toxic adenomatous goiter and 1 negro male had toxic non-exophthalmic goiter. Of the group with non-toxic adenomatous goiters there were 5 negro females and 2 negro males. Consequently, of a total of 571 patients with thyrotoxicosis, there were 40 negroes.

In order to illustrate clearly the variations of this symptom complex in the negro, we have selected from the 40 negro patients mentioned, 1 typical example of each of the following five main varieties of the syndrome.

I. THYROTOXICOSIS (EXOPHTHALMIC GOITER)

Approximately three-fourths (72.5 per cent) of our series of 40 negroes were classified as having true exophthalmic goiter. Definite bilateral exophthalmos together with constitutional evidence of thyrotoxicosis formed the basis for segregation into this group. The following case history is presented as a typical example of this group.

CASE 1. P. G. (Fig. 1), single, laborer, aged 33 years, native of Alabama. Patient was admitted to the surgical service on September 11, 1928, because of extreme nervousness, rapid loss of weight, and weakness. In December 1927, he began to have "attacks" of nervousness and he,

became very irritable. He states that he had some "financial trouble" at that time and that caused him to worry a great deal. The nervousness became progressively worse, he began to lose weight, and became completely fatigued after slight exertion. He was soon unable to work even when he could find a job. His friends noticed the increasing prominence of his eyeballs. During the latter part of the summer of 1928 he lost weight with increased rapidity and he became extremely weak. On admission to the hospital, he showed evidence of having lost a great deal of weight. His face and hands were flushed and very warm. Marked bilateral exophthalmos was present, and fine and coarse tremor of the extended fingers was noticeable. Pulse rate (at rest) averaged about 116 beats per minute. Blood pressure 165–90. The thyroid gland was slightly enlarged and soft. A thrill was palpable at both superior poles of the thyroid gland; there was a loud bruit over the entire gland. No adenomata were palpable in the thyroid gland. The heart was slightly enlarged to the left. The rhythm was regular but rapid. There was a systolic murmur at the apex. The radial pulses were equal, regular, and forceful. The lungs were normal. No œdema of ankles was present. The urine was normal. The blood Wassermann test was negative. Basal metabolic rate averaged +68 per cent.

Pre-operative preparation of complete rest in bed, high caloric diet, and iodine therapy (potassium iodide grains ii, t.i.d.) was carried out for a period of 16 days. The basal metabolism and pulse rates returned to normal. A subtotal thyroidectomy was performed on September 27, 1928. The postoperative course was uneventful. The patient was discharged from the hospital on October 5, 1928. Repeated follow-up examinations showed no return of the toxic symptoms. The photograph (Fig. 1) was taken several months after the thyroidectomy. There has been no appreciable chance in the exophthalmos. In March, 1930, the patient stated that he was able to do a full day's work without becoming fatigued.

II. THYROTOXICOSIS (JUVENILE EXOPHTHALMIC GOITER)

Exophthalmic goiter in children under the age of 12 years is unusual; nevertheless we have observed 2 colored children, 1 boy and 1 girl, each aged 7 years, with a very severe degree of thyrotoxicosis associated with marked bilateral exophthalmos. Fright and emotional disturbances seem to play a part in bringing on these symptoms of thyrotoxicosis in children as well as in adults. Lahey recommends a two stage thyroidectomy in children because most of them show a considerable rise in the pulse rate after a one stage subtotal thyroidectomy. He has, however, never observed a severe general reaction nor any signs of a thyrotoxic "crisis" in a child after thyroidectomy. He also stresses the importance of leaving sufficient thyroid tissue to care for the needs of the growing child and to avoid any danger of myxœdema.

The one negro child mentioned in this series who was submitted to thyroidectomy showed a marked rise in the pulse rate for several hours after the operation. The complete case history is as follows:

Case 2. E. D. (Fig. 2), school-boy, aged 7 years, native of Georgia. The patient was admitted to the surgical service on October 19, 1927, because of extreme nervousness, rapid loss of weight, and general irritability. On examination he was found to be a fairly well developed but undernourished young colored boy. He was very restless and irritable. There was marked bilateral exophthalmos. The skin of the face was moist and very warm. Both tonsils were enlarged and cryptic. The thyroid gland was uniformly enlarged and moderately firm. No adenomata were palpable. There was a slight thrill palpable at the left superior pole, but a bruit could be heard at both superior poles of the thyroid gland. The heart was enlarged to the left. There was marked precordial activity. Rhythm was regular; no murmurs. The lungs were normal. The radial pulses were equal, forceful, and the average rate (at rest) was 130 beats per minute. Blood pressure was 150–80.

Laboratory tests showed the urine to be of a high concentration (specific gravity 1.030) and to contain a slight trace of sugar. Blood sugar was 0.18 per cent. Red blood cell count was 4,560,000 and white blood cell count was 6,400. The basal metabolic rate averaged +75 per cent. The blood Wassermann test was negative.

After 15 days of complete rest in bed, high caloric diet, and iodine therapy (ferrous iodide and later potassium iodide) the subjective symptoms completely disappeared. The pulse rate returned to normal. The basal metabolic rate fell to +19 per cent, and the blood pressure remained only slightly elevated.

Subtotal thyroidectomy (single stage operation) was performed on November 3, 1927. There was a marked rise in the pulse rate immediately after the operation with only a slight rise in the general body temperature. The pulse remained of good quality but was very rapid for several hours. By evening the heart rate had returned to about 100 beats per minute and the state of excitability had passed. The remainder of the postoperative course was uneventful. The basal metabolic rate taken several days after the thyroidectomy showed only +2 per cent. The patient was discharged from the hospital on November 29, 1927.

The patient had a similar marked increase in the heart rate following the removal of his tonsils some months later. Careful examination failed to show any evidence of residual toxic symptoms and the basal metabolic rate was still normal. After the removal of the tonsils, the child gained weight and his general health improved greatly. We have been unable to locate the patient for more than a year so that final follow-up data cannot be given at this time.

III. THYROTOXICOSIS (UNILATERAL EXOPHTHALMOS)

The 2 following cases are reported separately because of the interesting history connected with the appearance of the unilateral exophthalmos in relation to the onset of the clinical symptoms of thyrotoxicosis. In the first patient (Fig. 3) the prominence of the left eyeball was present long before a definite clinical diagnosis of thyrotoxicosis could be made. In the second patient (Fig. 4) no exophthalmos was present at the time of the subtotal thyroidectomy but gradually over a period of months after the operation the left eyeball became prominent in spite of the fact

that there was no evidence of recurrent thyrotoxicosis.

CASE 3. S. D. (Fig. 3), widow, aged 43 years, out of work, dependent on charity, native of Mississippi. This patient was admitted to the medical service in April, 1929, in a semiconscious condition with high fever (41 degrees C.), rapid pulse rate, rapid respirations, and a marked prominence of the left eyeball. Physical examination of the chest at that time failed to reveal signs of pulmonary disease. Early thrombosis of the cavernous sinus was considered because of the marked unilateral exophthalmos. There was no change in the exophthalmos but some hours later physical signs of consolidation of the lower part of the right lung were present. Classical signs of lobar pneumonia then developed. The exophthalmos remained unchanged. Before discharge from the medical service a diagnosis of thyrotoxicosis was made because of the persistant tachycardia (120 beats per minute), increased basal metabolic rate, and the extreme excitability of the patient. She was given small doses of potassium iodide for several days and was then referred to the surgical dispensary for further follow-up examinations. After several months had been allowed for recuperation from the pneumonia she was referred into the hospital on the surgical service for complete iodinization and subsequent thyroidectomy. During her convalescence from the pneumonia she received small doses of potassium iodide each day.

Examination showed her to be extremely active, easily excited, and irritable. There were signs of marked vasomotor instability, marked exophthalmos on the left, slight prominence of the right eyeball also. The thyroid gland was slightly enlarged and quite firm. No nodules were palpable. A faint bruit could be heard at the left superior pole of the thyroid. No thrill was present. The heart was normal in outline. Rhythm was regular but rapid. There were no murmurs. Blood pressure was 150–80. The radial pulses were equal, forceful, and averaged about 110 beats per minute. There was a marked fine tremor of the extended fingers.

She dated the onset of the nervousness and excitability to "domestic difficulties" and "financial worries" which apparently reached their climax in the autumn of 1928, about 6 months prior to the attack of pneumonia. She had been trying in vain to provide for her three young children. For months she had been out of work and dependent upon charity. Because of lack of money she was forced to move from the place she had used for her home. The onset of all her present symptoms followed in the wake of this great crisis in her life. She denies ever having been ill prior to coming to the Great Lakes district.

Laboratory tests of the blood were normal. The urine showed many white blood cells but no albumin or sugar. The blood Wassermann test was negative. The basal metabolic rate averaged +82 per cent.

After about 2 weeks of complete rest in bed, moderately large doses of potassium iodide (grains iii, t.i.d.), and a high caloric diet, all the subjective symptoms disappeared. The pulse rate and basal metabolism returned to normal.

Subtotal thyroidectomy was performed on July 15, 1929. The postoperative course was uneventful. Repeated follow-up examinations have shown the patient to be in good health and free from all her former symptoms. She has gained weight rapidly. The unilateral exophthalmos has remained the same. Through the aid of the social service department the financial and domestic troubles of this patient have been corrected.

CASE 4. R. J. (Fig. 4), widow, housemaid, aged 39 years, native of South Carolina. She had lived in Cleveland for 23 years. She was originally admitted to the medical service because of marked loss of weight, nervousness, and palpitation. A diagnosis of Graves' disease was made and the patient was given iodine in the form of Lugol's solution (m V b.i.d.). After several days, this dose was increased to m XV three times per day. She stated that she had been worrying a great deal during the 6 or 7 months prior to the onset of her symptoms. Lack of money and the inability to obtain work seemed to be the basis of most of her worry.

After about 3 weeks of complete rest in bed and iodine therapy the patient was transferred to the surgical service for operation. Physical examination at that time showed only a slight enlargement of the thyroid gland. The gland was very firm. No thrill nor bruit were present over the gland. No exophthalmos was noted. There was marked increase in the general activity of the patient. The heart was enlarged to the left. There was a loud systolic murmur at the apex that was transmitted into the left axilla. There was a moderate fine tremor of the extended fingers. The radial pulses were forceful, equal, and the average rate was 85 beats per minute.

Laboratory tests showed the blood Wassermann test to be four plus (++++). The red blood cell count was 3,700,000 and the white blood cell count was 5,800. The urine showed a slight trace of sugar and a moderate number of white blood cells. Blood sugar was 0.096 per cent. The basal metabolic rate on admission to the surgical service averaged +35 per cent.

Subtotal thyroidectomy was performed on December 28, 1927. The thyroid gland was found to be well involuted by the iodine therapy. The postoperative course was uneventful and the patient was discharged from the hospital on January 26, 1928.

About one year later the patient was readmitted to the hospital on the urological service because of severe pyelitis. During this severe infection there was no return of the former thyrotoxic symptoms and the basal metabolism remained normal. It was during this admission that the prominence of the left eyeball was noted. The patient stated that during the year that followed the thyroidectomy, the unilateral exophthalmos slowly but constantly increased. The photograph (Fig. 4) was taken in February, 1929.

IV. THYROTOXICOSIS (TOXIC ADENOMATOUS GOITER)

Six of the 40 negroes showed moderately severe toxic symptoms associated with multiple adenomata of the thyroid gland. We believe that iodine therapy is indicated as a pre-operative measure in all cases in which there exists hypertrophic and hyperplastic thyroid tissue. The temporary involution caused by the iodine makes the subtotal thyroidectomy technically much easier and decidedly much safer. Unless sufficient thyroid tissue is removed, recurrence of the toxic manifestations frequently results. The following case (Figs. 5 and 6) illustrates the advisability of performing a subtotal thyroidectomy in patients who show toxic symptoms associated with an adenomatous goiter even when the thyroid gland at the time of operation shows only cystic and colloid adenomata.

CASE 5. E. G. (Fig. 5), widow, housemaid, aged 46 years, native of Kentucky. This patient was admitted to

the surgical service on December 19, 1927, because of loss of weight, shortness of breath, nervousness, and palpitation. Examination showed her to be moderately well developed but very poorly nourished. She was very restless and excitable. Her face and hands were moist and very warm. There was a moderate prominence of both eyeballs. She stated that she had had a "lump in her neck" for many years. There was a fairly large cystic adenoma in the right lower pole of the thyroid gland. Other small, firm adenomata could be palpated in both lobes. A faint bruit could be heard at the right superior pole. No palpable thrill was noted. The lungs were normal. The heart was considerably enlarged to both the right and the left side. There was marked precordial activity. A loud systolic murmur could be heard over the entire precordium. There were no diastolic murmurs. The blood pressure was 165–90. The heart rate was rapid (120 beats per minute), but the rhythm was regular. There was a marked fine tremor of the extended fingers. There was a slight œdema of the ankles.

Laboratory tests showed the urine to be of weak concentration (specific gravity 1.010) and to contain a marked trace of albumin (+++). No urinary casts were present. The blood sugar was 0.087 per cent. The red blood cell count was 4,160,000 and the white blood cell count was 4,600. The blood Wassermann test was negative. The basal metabolic rate averaged +63 per cent.

After 3 weeks of complete rest in bed, high caloric diet, and iodine therapy (potassium iodide grains ii, t.i.d.), the subjective symptoms completely disappeared. The basal metabolic rate remained slightly above normal but the pulse rate dropped to an average of 85 beats per minute.

On January 6, 1928, a resection of the right lobe of the thyroid gland was carried out. Numerous small colloid adenomata were present in the right lobe. The entire gland was well involuted by the administration of iodine. The postoperative course was uneventful. At the time of discharge from the hospital, there was no swelling of the ankles and no shortness of breath. The nervousness and irritability completely disappeared.

The patient remained free from her former symptoms for about one year. Financial distress and lack of work caused much worry to the patient. She again became nervous and irritable. In March, 1930, she was seen in the follow-up clinic because of the return of her former symptoms (Fig. 6). She had been losing weight rapidly and slight exertion caused complete fatigue. Physical examination showed a slight enlargement of the left lobe of the thyroid gland. The gland was soft and irregular in outline. There was a bruit at the left superior pole of the thyroid. No thrill was palpable. There was marked precordial activity. A loud systolic murmur could be heard at the base of the heart with a transmission of the murmur to the great vessels of the neck. The heart rate was about 110 beats per minute. The basal metabolism was again elevated. There was a fine tremor of the extended fingers. Because of the return of the toxic symptoms, the patient was referred into the hospital for subtotal thyroidectomy.

V. THYROTOXICOSIS
(TOXIC NON-EXOPHTHALMIC GOITER)

Only one negro of our series presented evidence of moderate thyrotoxicosis without exophthalmos. This type of thyrotoxicosis is frequently found among the white people of the Great Lakes district. This case is presented in a separate group in order to emphasize the fact that all forms of thyrotoxicosis can be found in the negro. The photograph (Fig. 7) was taken about 1 year after the thyroidectomy; consequently, the original characteristic anxious expression was no longer present. There was no evidence of exophthalmos at any time during the course of his illness.

Case 6. W. M. (Fig. 7), married, carpenter, aged 43 years, native of Kentucky. This patient was referred from the medical service to the surgical service on February 15, 1927. A diagnosis of thyrotoxicosis was made, and the patient was given complete rest and iodine therapy for a period of 1 month before being transferred to the surgical service. On admission to the hospital he complained of marked nervousness, loss of weight, shortness of breath, and swelling of the ankles. These symptoms came on gradually over a period of about 8 months during which time he had financial reverses and had great difficulty in supporting his family. Physical examination showed him to be a well developed but undernourished adult male negro. He was very restless and excitable. The face and hands were flushed and very warm. There was a slight enlargement of the thyroid gland. The gland was quite firm to palpation and no nodules could be felt. There was a faint bruit at the right superior pole of the thyroid gland. No thrill was present. The heart was slightly enlarged to the left. There was a loud systolic murmur at the base which was transmitted into the vessels of the neck. The heart rate averaged about 100 beats per minute. The lungs were normal. There was a slight, fine tremor of the extended fingers. There was a very slight pitting œdema of the ankles.

The laboratory tests showed the urine to be of normal concentration and free from albumin and sugar. The blood Wassermann test was negative. The red blood cell count was 4,897,000 and the white blood cell count was 7,600. The basal metabolic rate on admission was +41 per cent; the blood sugar was 0.12 per cent.

After 10 days of pre-operative preparation of complete rest in bed, high caloric diet, and Lugol's solution (m X t.i.d.), the subjective symptoms disappeared, the pulse rate became normal, and the basal metabolic rate was only slightly elevated.

Subtotal thyroidectomy was performed on February 26, 1927. The thyroid gland was found to be completely involuted. The postoperative course was uneventful. The patient was given Lugol's solution (m X t.i.d.) for about 1 week after the thyroidectomy.

Repeated follow-up examinations have shown the patient to be in excellent health and able to carry on his work as a carpenter without interruption. There have been no signs or symptoms of myocardial insufficiency since the thyroidectomy.

There seems to be no evidence that there is any racial immunity to thyrotoxicosis in the colored race. In the Great Lakes district where thyrotoxicosis is common among the white population, we also find a relative proportion of all the variations of this syndrome in the negro. We have presented typical examples of each of these varieties of thyrotoxicosis in the negro to show that there is no difference in the severity of the disease or in the response to treatment between the negroes and the native white people. The reaction

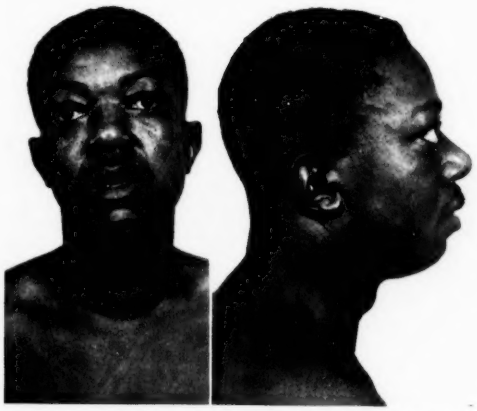

Fig. 1. Thyrotoxicosis (exophthalmic goiter).

Fig. 4. Thyrotoxicosis (unilateral exophthalmos which appeared after thyroidectomy).

Fig. 2. Thyrotoxicosis (juvenile exophthalmic goiter).

Fig. 5. Thyrotoxicosis (toxic adenomatous goiter).

Fig. 3. Thyrotoxicosis (unilateral exophthalmos present before operation).

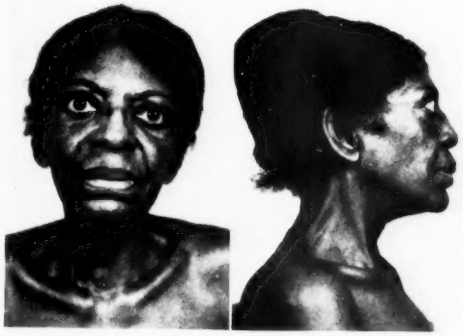

Fig. 6. Thyrotoxicosis (recurrent one year after lobectomy, Figure 5).

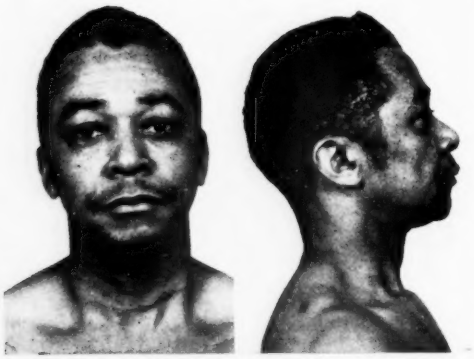

Fig. 7. Thyrotoxicosis (toxic non-exophthalmic goiter).

to iodine and subtotal thyroidectomy is identical in the two races. It has been repeatedly pointed out by Allen Graham that there is no essential difference between the response to iodine in cases of exophthalmic goiter and in cases of toxic adenoma of the thyroid gland. Increased basal metabolic rate and other evidence of "thyrotoxicosis," together with hypertrophy and hyperplasia of the thyroid of any degree, are regarded by Graham and Cutler as sufficient indication for the administration of iodine, irrespective of the presence or absence of adenomata. Harris states that the administration of iodine to negroes with toxic adenoma of the thyroid is harmful and he states that one of his patients was made worse by such therapy. In our entire series of toxic adenomatous goiter in both the white and the colored races we have had uniform improvement in all subjective symptoms after the administration of iodine in the proper amounts.

Sudden psychic shock, financial worries, and domestic difficulties seem to play an important part in precipitating this symptom complex in the negroes as well as in native white people. For this reason we have taken special care to study the living conditions of these patients and, through the co-operation of the social service department, we have been able to get most of these patients back to a normal self-supporting life after their period of convalescence.

SUMMARY

1. Thyrotoxicosis is not an uncommon disease in the negro.
2. All varieties of the symptom complex have been observed in the negro.
3. The reaction to iodine therapy and subtotal thyroidectomy is essentially the same as in the white race.
4. There is no evidence that iodine therapy is contra-indicated in cases of toxic adenomatous goiter in the negro.
5. Psychic shock, financial worries, and domestic difficulties seem to play a part in precipitating this symptom complex in the negro.
6. Removal of such irritating factors should be an essential part of the postoperative treatment of thyrotoxicosis in the negro.

NOTE.—The author wishes to thank Miss Mary Post, of the social service department of the Lakeside Hospital, for the excellent co-operation she has given us during the study of these patients.

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VASCULAR ANOMALIES OF THE EXTREMITIES

REPORT OF FIVE CASES[1]

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VASCULAR anomalies occur, when some part of the primitive vascular network is retained or transformed to a more adult arrangement, without undergoing definite stages of development (Baader, 1866). Woollard, in careful studies of vascular development in the forelimb of the pig, recognized three stages in the formation of an individual arterial tube, namely: (1) the stage of capillary network, (2) the stage characterized by enlarged tubes showing island formation, coalescence, and tendency to fuse (retiform stage), (3) the formation of a definite stem, with disappearance of other vascular units.

The clinical nomenclature of vascular malformations and growths is confusing. Borst has repeatedly emphasized that true angiomata must show evidence of endothelial proliferation and formation of syncytial network. Most of the so called angiomata, however, are only angiectasias, that is dilatation and lengthening of arteries, veins, or both. They represent developmental anomalies, and their growth may be readily explained by a continuous filling from the arterial system, with which they may be connected. The capillary angiomata of the skin, vascular nævi, and the cavernous hæmangiomata of the liver are typical examples of developmental anomalies and are not true tumors in the histological sense of the word.

The racemose angioma, occurring on the head, lower and upper extremities, has obviously a congenital anlage, but a transformation of a simple angioma into a racemose angioma by trauma is rarely but definitely established (Sonntag). These tumors are described as consisting of a mass of small and finest arteries, less elastic, and gaping in cross section. A proximal nutrient artery is dilated, while distally only a short segment is involved. Later a dilatation of veins appears and communications are established between veins and arteries. Pregnancy and muscular exertion accelerate their growth.

The diffuse phlebarteriectasia and the diffuse phlebectasia is described by Sonntag in detail. The dilatation is limited to existing vessels and a new formation of vessels cannot be demonstrated. Their origin is congenital but they sometimes become manifest at puberty or even later. Communications between veins and arteries are possible but are supposed to be secondary.

Congenital arteriovenous communications have been described in detail by Callander and Pemberton and Saint. There may be a few or a large number of communications between arteries and veins, and the oxygenation of the venous blood can be definitely demonstrated. Brown pointed out that the color of the mixed venous blood when compared with a normal venous blood is usually sufficient to establish a diagnosis of arteriovenous communication.

In recent years a great deal of experimental work and clinical observations have been made on the physiology of arteriovenous fistulæ, by Halsted, Matas, Reid, and Holman. While experimental fistulæ imitate conditions which are present in traumatic or syphilitic aneurisms with large communications, the findings of these authors are also very important for the understanding of the multiple congenital arteriovenous fistulæ. The decrease in peripheral resistance, increase in venous pressure, increased volume of blood, and increased heart action are briefly the general cardiovascular effects of such communications. Naturally, the smaller and less numerous the openings are, the less noticeable the systemic changes are going to be. Holman showed that the presence and intensity of the thrill is dependent on a free flow of blood to the heart from the fistula. Contrary to most American workers, Lewis and Drury believed that there is no increase in the general venous pressure in arteriovenous aneurisms and that the dilatation of the heart is due to a faulty circulation in the coronaries.

The differential diagnosis of angioma simplex, cavernous and racemose angioma, diffuse phlebectasia, and congenital arteriovenous fistula is sometimes impossible. Transitions from one group to the other are frequent. In studying the cases described in the literature and after having observed the 5 cases to be discussed, it seems fair to assume as a working hypothesis that (1) *none of these vascular tumors are true growths and are all due to faulty development* and that (2) *the variations encountered are due to the stage of vascular development in which the aberration from the normal occurred.* Thus the capillary angiomata (vascular nævi) are localized remnants of the primitive capillary net. They remain harmless birthmarks until a sudden connection with the general circulation

[1] Since this article was written 3 additional cases have been studied. Two of these came to operation, with good functional results. One patient received injections of a sclerosing solution with partial relief.

Fig. 1, left. Dorsal aspect of left hand, Mrs. P. T. K. There is considerable dilatation of the normal veins, but no abnormal venous masses.

Fig. 2. Volar aspect of left hand, Mrs. P. T. K. Note the venous masses on the fingertips, which were very painful and became inflamed repeatedly.

starts feeding them with blood, in which case progressive cavernous dilatations develop, which grow destructively owing to the continuously increased pressure. Trauma has definitely been established to start a simple angioma to expansion.

The diffuse phlebectasia and the congenital arteriovenous communications may take origin in the second, retiform stage of development. A number of parallel vascular tubes which have not fused sufficiently and are connected with multiple communications, represent a developmental arrest in the second stage. Some of these cases only show a few tiny communications and their surgical attack is simple. Other patients show such innumerable and inapproachable communications, that they are practically inoperable, and lead to a progressive gangrene and amputation.

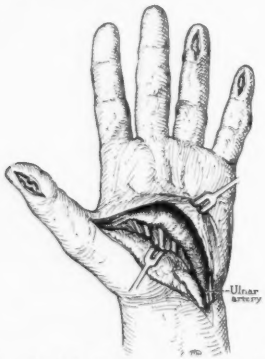

Fig. 3. Sketch of findings at operation, Mrs. P. T. K. The ulnar artery was exposed. It was tortuous, sclerotic, and entered into a convolute mass of veins, which pulsated. The mass extended from the wrist into the deep palmar arch, was freed and Carrel clamps were applied both distally and proximally.

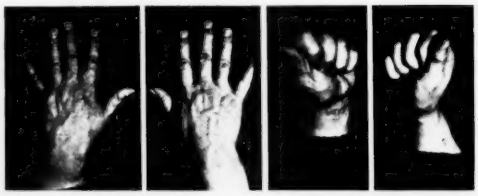

Fig. 4. Good function of left hand, Mrs. P. T. K. 2 years after operation. The right hand is shown for comparison.

It is also conceivable that the vascular development reaches the third stage, namely that of definite stem formation, but that one of the primitive vessels has persisted and presents an anomalous primitive trunk with a histological structure, which does not correspond to either the histology of an artery or that of a vein. Case 3 belongs to this group.

The physiological effects of such vascular anomalies have interested the experimentator, but few studies are available on clinical cases. It is attempted here to give a composite picture of the conditions observed in the five patients although not all studies have been made on all cases. The heart, the changes in pulse, blood pressure, the color and oxygen content of blood in the dilated vessels, and the blood volume were studied. Finally, in one case, an attempt was made to visualize a feeding artery of a large gluteal angioma with X-ray after injecting an opaque substance into the dilated vessels.

The treatment in all the 5 cases was surgical. Conservative treatment with elevation, elastic compression is obsolete. Injection of absolute alcohol, 2 to 4 cubic centimeters every third day, was tried in 1 case (Case 3) without success. In another patient, however, after radical excision was performed on the thigh, the remaining dilatations below the knee could be readily obliterated with 10 per cent quinine-urethane solution, as used in the treatment of varicose veins. The arterial inflow of blood, however, particularly if multiple communications exist, will exclude any permanent obliteration by injections, unless the chief feeders are ligated.[1]

Radium treatment of these vascular growths is successful on the face, tongue, and larynx if one is dealing with circumscribed vascular nævi (Simpson). I have used radium on angiomata of the orbit as a preliminary step to radical excision. It shrinks the vessels, reduces hæmorrhage at op-

[1] In a more recent case massive injections of sodium morrhuate into a large aneurismal sac in the calf, relieved the symptoms, at least temporarily.

Fig. 5. Case 1. Section taken from a fingertip shows a thrombotic vein with marked hypertrophy of the wall. The vein is arterialized because of the high pressure of the arteriovenous blood. There is no evidence of intimal proliferation. The veins of the fingers are simply dilated because of the communication of artery and vein in the palmar arch. Repeated diagnosis of hæmangioma of the hand was made in this case. ×85.

eration, but if the "angioma" is due to anomalous communications, the feeders are not affected. On the extremities the extent and depth in which these vessels are found makes exclusive treatment of radium of dubious value.

The early surgery of these lesions consisted of simple proximal ligations of arteries (Sonntag). Unfortunately this is not sufficient. In Case 1 the radial artery had been tied, later venous dilatations were excised, and finally I had to tie the ulnar artery and excise a congenital aneurism in the palmar arch. If the anomaly consists of a single or few abnormal communications, they are simply ligated and thus the perverted physiology of circulation is restored to normal. Such fistulæ have been seen on the neck, between common carotid and jugular veins. On the extremities the communications are usually very extensive and the resulting proximal and distal dilatations may transform the limb into a spongy mass, which invades the muscle and may even be present in the bone marrow. The object of the very radical operations must be to excise the whole vascular tumor and yet leave enough circulation to prevent gangrene. Usually an intensive collateral circulation develops around the arteriovenous fistulæ.

The circulatory embarrassment distal to the fistulæ manifests itself in a cyanosis of the acra. Thus in Case 3 the fourth and fifth toes were

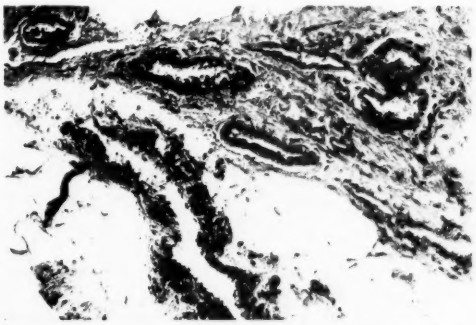

Fig. 7. Case 2. Embedded in loose connective tissue there are a number of blood vessels with a great variation of structure. The intima is unusually thick, muscle is present, but elastic tissue is difficult to identify. The lumina of both the thick walled and thin walled veins are frequently subdivided into compartments by thin septa. ×125.

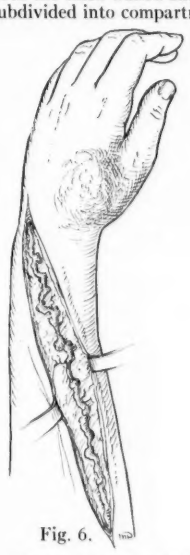

Fig. 6.

Fig. 6. Phlebectasia in a superficial vessel of the right arm. Note the multiple sacculations and the intimate relationship with the median cutaneous nerve. No venous enlargements below the fascia. The vessel was excised from the middle of the forearm to wrist. No connection with the arterial tree.

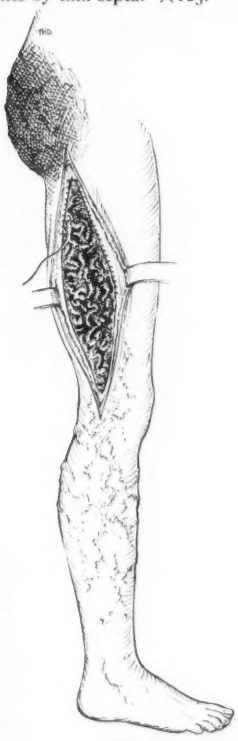

Fig. 8.

Fig. 8. Case 3. A large spongy mass of dilated vessels extended from the skin down to the deep fascia and into the muscles. The edges of the muscle fascia had to be whipped with interlacing sutures to control the bleeding. The whole mass was removed.

Fig. 9. Visualization of anomalous blood vessels with 30 per cent uroselectan. Between two tourniquets, 20 cubic centimeters of the opaque solution was injected and a soft X-ray exposure was made within 10 seconds. Note a large vessel which could later be injected and caused marked collapse of the venous mass in the gluteal region.

cyanotic and in spite of three extremely radical operations remained so. When the arterial blood follows the least resistance in to the veins, blood is shunted from the capillary bed and thus the tips of the extremities are poorly nourished. Together with the cyanosis a drop in surface temperature takes place, also indicating the poor inflow of blood. This may progress into a gangrene, requiring amputation. In Sonntag's series 4 of the 12 cases of "genuine diffuse phlebarteriectasia" ended in amputation. A very disturbing complication is the appearance of migratory attack of phlebitis in the distal venous dilatations. This was observed in Case 1 and led to a great deal of suffering. It has not recurred since the operation.

Another serious complication is the appearance of multiple miliary capillary aneurisms as small dark red spots on the skin. In the fourth patient, these miliary aneurisms would bleed like a fountain on the slightest provocation. Heavy doses of X-ray were used to check them, as they had not subsided after the excision of the abnormal vessel.

Owing to the increased venous pressure, these limbs are œdematous and painful when in the dependent position. The first patient had her arm in a sling and kept her arm on a cushion when she rode in a car. Bandaging gave her and another patient of this series some relief. In some patients elephantiasis-like pictures develop with a sclerosis of the connective tissue, which is hardly a reversible process. This all adds to the difficulty of surgical management.

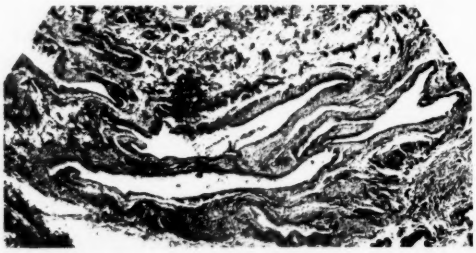

Fig. 10. Photomicrograph containing a large number of blood channels varying from tiny capillaries to large sinuses. The latter have a differentiated wall, on which muscle can not be identified. They show irregular folds as an evidence of unusual and abnormal distention. Some hypertrophy of the intima but no real proliferation. ×36.5.

Proximal to the fistulæ, a dilatation of arteries and veins occurs. The thrill at the site of fistulæ, which is so characteristic in the traumatic arteriovenous communications, was absent in this series, because the congenital communications are too small to give a thrill. Theoretically, the blood pressure should be lower on the affected extremity, as a part of the peripheral resistance is excluded. In the first patient the systolic pressure was sixteen points lower and the diastolic ten points. In the fourth patient the systolic pressures were equal, but the diastolic pressure was ten points lower. Oscillometric readings taken in the two patients in whom the lower extremities were affected, showed increased oscillations above—diminished oscillations below the fistulæ. Obviously the pulse volume is greater above the fistula, but only a part of it reaches the distal parts. The effort to compensate for this loss was studied experimentally by Holman. A definite increase in blood volume takes place which in turn influences the minute volume of the heart and overloads it. In the one patient, in whom blood volume was studied there was a marked decrease after the operation. It is well known that all aneurisms lead to dilatation of the heart. In our first case, there was a definite enlargement of the heart with an accentuated second aortic tone. However, this was probably due to a co-existing hypertension on an arteriosclerotic basis. The other patients showed no heart changes.

Interesting is the bradycardic phenomenon, occurring when pressure is exerted at the site of ar-

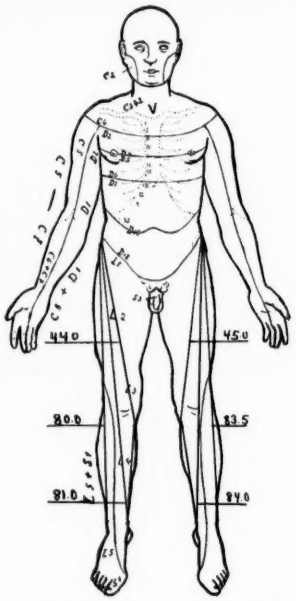

Fig. 11. Measurements of the lower extremities in Case 4, indicating a marked hemihypertrophy of the left limb. There is a maximum difference of 3 centimeters measured between anterior superior spine and inner ankle, indicating that the increased blood supply was operating before the closure of the epiphyseal line.

teriovenous anastomosis. This sign described by Branham, is usually called after this author (Reid), but as pointed out by Dean Lewis has been described many years ago by Nicoladoni. It was present only in our first case, when a great volume of blood was sidetracked.

The hemihypertrophy of the affected extremity described by many authors in conjunction with congenital arteriovenous fistula (Harris, Horton) was very marked in our fourth case, when the increased blood flow was operating before the closure of the epiphyseal line. A marked sympathetic disturbance was observed in Case 2—there was no difference in length, however.

Fig. 13. A 13 centimeter segment of a blood vessel, the diameter of which is from 6 to 8 millimeters. The thickness of the wall was from 1 to 2 millimeters. The lumen was almost completely obliterated by a blood clot.

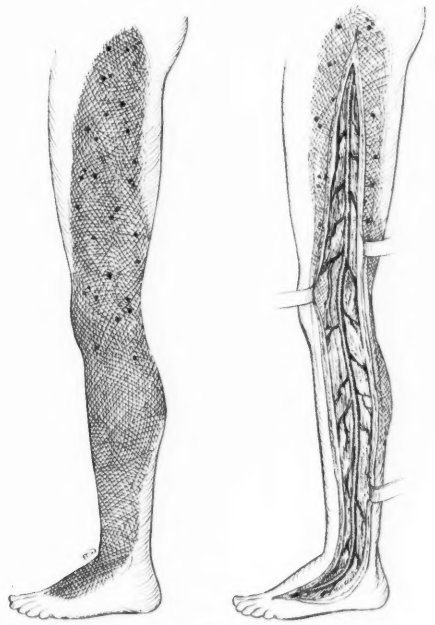

Fig. 12. Operative findings in Case 4. Note the large anomalous vessel below the superficial fascia, which is exposed from thigh to dorsum of the foot. This is a composite diagram of three successive operations. The shaded area represents the extent of the cutaneous birthmark, while the small black dots illustrate the distribution of multiple capillary angiomata, which bled readily.

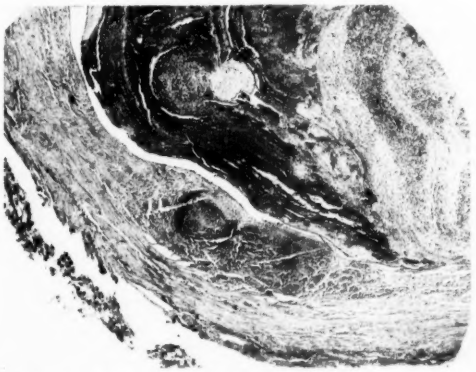

Fig. 14. Photomicrograph of the anomalous vessel in Case 4. A segment of the large vessel shows an irregularly thickened wall, which has the thickness of an artery, but is very poorly differentiated into layers. The media adjacent to the intima contains a large number of longitudinal muscle fibers, which, according to Maximow, occurs in primitive, non-differentiated vessels. No elastic membrane is seen. The lumen is almost completely occluded by a large thrombus, which shows organization in places. ×256.

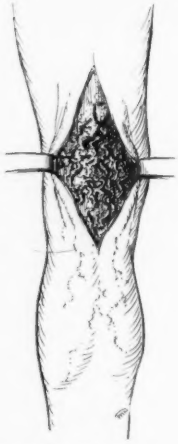

Fig. 15. Operative findings in Case 5. A spongy vascular mass was exposed in the left popliteal fossa. It had no relationship to the internal saphenous vein or to the deeper vascular structures and was entirely suprafascial. The mass did not pulsate but the color of the blood was bright red, not venous.

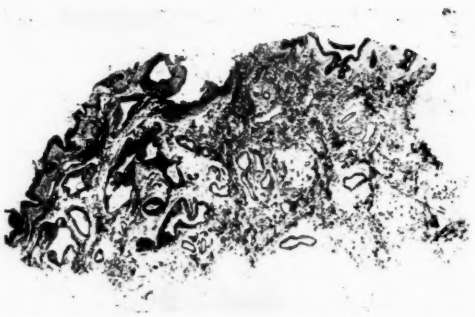

Fig. 16. Section of the vascular mass in Case 5. A large number of blood vessels are seen, with a hypertrophic intimal lining. It represents a primitive vascular network, but no evidence of angioma formation.

CASE REPORTS

CASE 1. Mrs. P. T. K., aged 58 years, referred by Dr. W. H. Stearns, was admitted to the Evanston Hospital on July 17, 1928 (Hosp. No. 71014), complaining of pain, throbbing, and repeated attacks of phlebitis in the left arm. She also stated to have knowledge of her high blood pressure and a mild diabetes.

At the age of 12 or 14 she fell on her left arm from a haystack but does not think her arm was broken, as the function of the arm was not impaired. However, she thinks that dilated veins began to appear from this time. The veins would enlarge with every pregnancy. There were four deliveries, the first of which was normal. At the second time twin girls were born with instrumentation, followed by laceration of perineum and postpartum infection. The third time a 10 pound baby was delivered with forceps and a severe postpartum infection developed.

Since 1912, recurrent attacks of phlebitis occurred in the left arm; the first attack followed an appendectomy and drainage of gall bladder. The latter was undertaken because of severe attacks of vertigo lasting from 2 to 22 hours. In 1913, the gall bladder and ovaries were removed, a cystoscopy performed for possible kidney stones, the tonsils removed, and nine teeth extracted because of "neuritis" in left arm. In 1918, another laparotomy was done. A Lane's "kink" was found and the uterus was removed. In 1919, an operation was performed on her left arm and hand. So far as can be ascertained, at the first operation the radial artery was tied and some of the venous dilatations excised; at the second operation performed by another surgeon, in 1923, with the diagnosis of hæmangioma, multiple excisions of venous masses were made. The scars from these incisions caused a lot of pain. In 1926, a floating kidney was treated with supportive measures and the ureters were dilated by Dr. B. L. Corbus. This treatment gave the patient complete relief from her back pain. In 1927, diabetes was discovered and her diet regulated by Dr. Woodyatt. On a final diet of 77 grams of carbohydrate, 52 grams of protein, and 101 grams of fat, a glucose value of 118 and total calories of 1325 she became sugar free. The pain in her arm and the occipital headaches and dizziness continued.

Since 1910, patient has also been subject to repeated "nervous break downs" with melancholy, and has been under the supervision of Dr. W. H. Stearns, who referred the patient for study of the vascular condition of her arm.

The physical examination (only pathological findings recorded here) revealed a deafness of the right ear, distant heart tones without any murmurs, second aortic tone short and accentuated. Blood pressure on the right arm 150-96, on the left 134-84. A smooth palpable mass in the right upper quadrant could be replaced into the lumbar region (floating kidney). The left arm showed dilated compressible masses at the elbow, on the ulnar side of the flexor surface of the arm, and on the fingertips. The dorsal surface of the hand showed marked dilated veins but no venous masses (Figs. 1 and 2). There were painful hypertrophic scars at the elbow, at the wrist above the radial artery, and on the tips of the fingers. The fifth finger showed a partial ankylosis in the last phalangeal joint.

The arm showed a definite rubor in the dependent position, and was kept in a sling because of pain when hanging down. There was no pulsation felt at the radial artery. The ulnar artery pulsated well. There was no thrill heard or palpated over any of the venous dilatations. A number of small phleboliths were palpable as a result of the previous attack of phlebitis. The muscles of the arm were flaccid; the whole arm seemed atrophic as compared with the right side. At the middle of the forearm the difference in circumference was two-tenths of an inch. The grasp of the left hand was feeble, but motions were not limited in any joint except in the phalangeal joint of the fifth finger.

The Wassermann reaction was negative. The urine was free of pathological elements. The blood sugar was 0.120 grams per hundred cubic centimeters. X-ray examination revealed evidence of osteo-arthritis of the phalanges in both hands. There was a good deal of thickening of the soft tissues of the arm, forearm, and hand, and definite deposits due to old phlebitic calcifications.

A gas analysis of blood from one of the enlarged masses revealed a carbon dioxide content of 52.54 volume per cent, an oxygen content of 19.12 volume per cent, with an oxygen capacity of 20.82 volume per cent (Miss P. J. Crittenden). The method of Austin was used.

On the basis of the above gas analysis, the diagnosis of an arteriovenous communication was certain. In spite of the

history of trauma, the impression was rather that multiple congenital communications existed. No bruit was present. Pressure on the wrist, however, decreased the pulse from 86 to 60.

On July 19, 1928, under brachial plexus block with 20 cubic centimeters of 2 per cent procaine, an old healed scar in the elbow was first excised. The cubital artery and veins were exposed and were found normal. An old phlebitic induration above the upper part of the ulna was excised. The ulnar artery was exposed and was followed down into the deep palmar arch. The artery was elongated, tortuous, sclerotic, and formed one inseparable mass with a convolute mass of veins which pulsated and carried visibly arterial blood (Fig. 3). This mass extended from the wrist into the deep palmar arch and was freed in a length of 8 centimeters. After applying Carrel clamps, both distally and proximally, the blood supply of the hand still seemed satisfactory. The whole mass then was excised after ligation of small communicating vessels with Carrel silk. A small rubber tube was inserted at the most distal point. The wound healed without any reaction except for an iodine dermatitis, which subsided under mentholated zinc oxide paste. On March 2, 1928, under finger block, enlarged venous dilatations on the volar surface of the thumb, fourth and fifth fingers were excised. They bled profusely an oxygenated, arterial blood which contained phleboliths. Their nutrient arteries were tied with No. 000 catgut and dermal sutures united the skin.

Following the operation there was no sign of impaired circulation. The hand was warm, pink, and no œdema developed. Gradually after the healing of the incisions, massage was started. The hand had not been in use for almost 15 years. At the present time, 3 years after the operation, patient uses her hand freely—can play golf (Fig. 4). There is a hypertrophic scar at the wrist and occasionally a feeling of fullness is still present. Patient lives in the East and is seen only infrequently. She reports, however, a continuous improvement in her hand but that the hypertension seems to give her more trouble.

Histological findings. The entire specimen, as excised, could unfortunately not be preserved as the histological work necessitated cross sections of the mass. In the sections, several veins with thickened, irregular sclerotic walls were seen. One vein contained a small, hard white nodule, with a calcified degenerated center. In one place there was an organized and partially healed thrombus. At another a small, more recent thrombus. The structure of these vessels nowhere suggested an artery (Fig. 5).

In another section, however, vein and artery lay closely side by side plastered to each other, but no communication at least at the level of the sections could be detected.

Summary. A 58 year old patient, who gave the history of progressive vascular dilatations of the left arm and hand since a trauma at the age of 12, has several attacks of phlebitis, and an increasing disability of the left hand. Two previous operations were performed, but the fistulæ were not recognized. A radical excision of the ulnar artery with fistulous openings did not impair the circulation of the arm, although the radial artery had been previously tied. A great deal of relief followed the operation, and no reappearance of further dilatations is present after 3 years. Patient, who has not used the arm for 15 years, now plays golf.

CASE 2. H. L., aged 21 years, single mechanic was first seen at the Northwestern University Clinic, complaining of a progressive dilatation of the veins on the right wrist and forearm, with aching pain when the arm is used. He had noticed "varicosities" about 8 years ago, at the age of 13. The veins were first enlarged at the wrist, but gradually an involvement of the radial side of the forearm took place. After the arm was exercised a dull, aching pain occurred, which prevented him from working. For the last 3 years patient also has noticed a marked flushing of the right half of the face and increased perspiration.

Outside of occasional headaches, patient's inventory by systems is negative. He had had measles, mumps, and whooping cough in childhood. There is no history of cardiac disease or vascular anomaly in his family.

On physical examination (only positive findings recorded here) there was found a chronic inflammation of tonsils and pharynx. There was a diffuse enlargement of the thyroid gland, rather soft and not pulsating. The pulse was 96, blood pressure 120-80. On the right upper extremity a dilated vein was seen on the dorsal surface of the forearm from the tuberosity of the radius to the middle of the forearm. In the dependent position, the filling of the vein was more marked. It showed several saccular enlargements and small ramifications. There was no pulsation in this vessel. The blood pressure in the two arms was equal.

Of the laboratory findings, the red cell count was 3,670,000, the white count 7,900, the hæmoglobin 75 per cent. The urine was normal. Wassermann and Kahn reactions were negative. The oxygen content of the blood taken from the dilated vessel was 18.2 per cent; it was higher than that of the cubital vein on the other side, which was 17.1 per cent.

On November 2, 1929, under brachial plexus block with 20 cubic centimeters of 2 per cent novocain with adrenalin, an incision was made along the radial side of the right arm from the middle of the forearm to the wrist. A large vessel was exposed, showing sacculations (Fig. 6). There was an intimate relationship with the median cutaneous nerve. There seemed to be no connection between the venous dilatations and the arterial system. The vein was followed to the level of the wrist, where it appeared to be normal. There was no enlargement of the deep veins, as ascertained by a slit in the fascia. The vessel was ligated with fine catgut, proximally and distally. The skin was sutured with continuous dermal suture. Postoperative diagnosis: congenital phlebectasia of right arm.

The postoperative course was uneventful. The pathological report was made by Dr. S. Vaughan (Fig. 7). Grossly the specimen consists of an elongated mass of loose connective tissue, containing conspicuous blood vessels which have an average diameter of about 4 millimeters. At irregular intervals saccular dilatations are observed, which attain a maximum diameter of about 7 millimeters. Microscopically, the loose connective tissue is found to contain, besides a quantity of fat, a large number of blood vessels of considerable size. These show a great variation of structure. Most of them have rather thick, but irregular, walls. Muscle is present in them but there is an excess of connective tissue. At the level of the saccular dilatations, the wall is greatly thinned. The linings of the vessels are composed of endothelial cells, which are rather larger and thicker than normal. Elastic tissue in the walls is difficult to identify. The lumina of both the thick and thin walled vessels are frequently subdivided into compartments by thin septa, which are continuous with the walls.

Summary. A young man of 21 complained of progressive dilatations of the veins on the right wrist and forearm, with aching pain when the arm was used. The enlargements were first noticed at the age of 13. There was also a marked

flushing of the right half of the face and increased perspiration. An anomalous vessel, showing an abnormal histological picture was excised and patient's complaints subsided. No further enlargements are present after 2 years.

CASE 3. Joseph de F., aged 20 years, was referred by Dr. Paul B. Magnuson. He was admitted to Wesley Memorial Hospital on September 9, 1930, complaining of inability to work because of progressive vascular enlargements of his right leg and thigh. He first noticed a discoloration of the lateral surface of the right leg and thigh at the age of 5 years. This remained fairly stationary until 6 years ago, when, at the age of 14 there was a rapid development of a round, blue spot in the right popliteal fossa. Within a year the mass developed to the size of an orange and became very painful. Five years ago this growth and a portion of the extension on the thigh and lower leg were removed by a physician in Kenosha, Wis. Two years ago he began to have pain again on the lateral surface of the right leg and thigh and was told to wear a bandage. This gave him relief until about 4 months ago when a persistent aching pain developed when he walked. The pain could be relieved by sitting down or lying down.

A year ago a red spot developed on the inner side of the right thigh. This also gradually increased up to 5 centimeters in diameter.

Past history was negative except for tonsillectomy at the age of 10 years. There was no history of any vascular anomaly in the family. Physical examination (only positive findings) revealed a bluish discoloration of the right half of the scrotum, about 3 centimeters in diameter, and slightly raised. The testicles were in the scrotum. The bluish discoloration disappeared on pressure and was obviously due to dilatation of the minute vessels of the skin. There was the same irregular, bluish dilatation of the skin vessels extending from the superior border of the gluteus maximus muscle down to the middle of the thigh on the external side. This was not a capillary telangiectasis, but visible dilatations of small vessels, possibly venules. There was a linear scar about 25 centimeters long on the lateral surface of the thigh and lower leg. There were extensive venous dilatations distal to the knee extending down to the ankle. The whole picture corresponded to a so called hæmangioma cavernosum.

The reflexes were normal.

First operation was performed on September 11, 1930, under spinal anæsthesia with 3 cubic centimeters of spinocain and 100 milligrams of ephedrine. An incision was made about 25 centimeters long on the lateral surface of the thigh down to the knee joint. A large spongy mass of dilated vessels extended from the skin down to the deep fascia and even below that into the muscles. A generous oval incision was made into the muscle fascia and the edges were immediately whipped with locking hæmostatic sutures (Fig. 8). Thus as much of the vascular mass as possible was removed. The skin flaps had to be retracted considerably and were very thin when united with interrupted silkworm gut. A great many suture-ligatures were used to control the bleeding.

The patient was in good condition following the operation but on the eleventh day a rupture of the suture line occurred. The edges became necrotic, and the sutures cut through. Also an enormous hæmatoma had formed under the skin, the pressure of which may have helped to burst the suture line. The hæmatoma was evacuated. No bleeding points were found. The edges of the wound were trimmed and resutured. Gauze rolls were sutured over the incision to act as pressure pads.

On September 25, 1930, 3 days after the secondary suture, there was definite evidence of an anærobic infection. There was a peculiar sweetish odor of the serosanguineous exudate, and definite gas bubbles in the discharge. The gas formation was noted a few days after the first operation but did not seem to blow up until the resuturing of the wound. Treatment with hydrogen peroxide and anti-gas gangrene serum was ordered.

As the patient was running a septic temperature and had developed a marked anæmia (2,500,000 red blood cells, 40 per cent hæmoglobin), 500 cubic centimeters of citrated blood were transfused on October 4, 1930. This changed the whole picture. The septic temperature subsided, the granulations took on a healthy appearance. The seriousness of his previous condition was evidenced by the fact, that, in spite of the wound infection and the septic temperature, the leucocyte count was around 5,000.

The patient now made a slow, but steady recovery. The wound was dressed daily with dichloramine T. He was up all day for the first time on October 21, 1930. On October 30, 1930, a large, venous dilatation in the popliteal fossa was injected with 1 cubic centimeter of 10 per cent quinine urethane. The vessel became promptly obliterated. On November 2, 1930, two further injections were made in the calf with the same result. He was discharged from the hospital and was dressed in the office twice a week. The wound completely healed on January 3, 1931. At this time there was a complete obliteration of the veins of the lower leg. The ankle was not swollen. The knee joint seemed to contain fluid. About 50 cubic centimeters of a serous transudate was aspirated. The vascular dilatations on the thigh had not recurred. The hæmangioma of the scrotum and gluteal region were present but did not seem to cause any disturbance. The patient was now free of pain, but the limb was weak and the knee joint would fill up intermittently with fluid.

On April 5, 1931, the gluteal portion of the hæmangioma was injected with 20 cubic centimeters of skiodan, and a very instructive picture was obtained. A large feeding vessel was visualized, which may represent the connection with the general vascular system (Fig. 9). This feeding vessel was later injected with a 10 per cent quinine urethane solution, which resulted in a marked decrease of the mass.

The histological report (Dr. S. Vaughan) of the removed vascular mass was as follows (Fig. 10): Specimen weighs 41 grams, it consists of 3 pieces of tissue 7 by 4 by 2.5 centimeters; 5 by 4.5 by 3 centimeters; and 2 by 2 by 0.75 centimeters. It is made up of fatty connective tissue, trabeculated, containing vascular structure. Histologically stained sutures show fibrous and fatty connective tissue in which are seen a large number of blood channels, varying from tiny and normal appearing capillaries to large sinuses. The latter have a differentiated wall in which muscle cannot be readily identified. They are often divided into compartments by irregular folds. The lining for the most part is of normal endothelium, but in places there is evidence of hypertrophy and hyperplasia.

Summary. A 20 year old boy had noticed bluish discolorations on his left leg, thigh, and scrotum since the age of 5 years. At the age of 14, with the onset of puberty, a rapid enlargement of the vascular dilatations took place. Particularly the mass in the popliteal fossa grew rapidly. At the age of 15, an operation was done with a partial removal of the growths, which gave the patient temporary relief for 2 years. He then

began to have more pain, and the growth increased in size. A radical excision of the growth was done on the thigh. The scrotal and gluteal involvement was not attacked. The veins in the popliteal fossa and on the calf were injected with quinine urethane. The progress of the disease seems to be arrested although only 7 months have elapsed since the operation.

CASE 4. Agnes D., 16 years old, office clerk was admitted from Northwestern University Clinic to Wesley Memorial Hospital on July 28, 1929, complaining of swollen veins in the left leg and repeated hæmorrhages from rupturing small vessels. Patient first noticed a swollen vessel on the lateral surface of the left calf at the age of 10 years. But ever since birth there has been a large port-wine birthmark extending from the thigh to the ankle on the outer aspect of the limb. There was no history of any vascular anomaly in her family. At the age of 13 she was taken to Cook County Hospital. She was given several treatments of X-ray after which the dark red birthmark faded but the dilated vessels were not affected. Later radium was applied without any noticeable effect. On examination, a well grown, healthy young girl of about 15 years of age showed a slightly enlarged heart with a second pulmonic tone accentuated. There was a marked systolic murmur at the apex. The right lower extremity seemed perfectly normal. The left lower extremity was definitely œdematous. A large, somewhat faded port-wine stain extended from the thigh through the lateral and posterior aspect of the calf to the ankle. The limb was studded with small capillary dilatations and also larger vessels, which protruded and greatly enlarged on standing. The limb was 3 centimeters longer than its fellow, the lengthening being present between the knee and ankle (Fig. 11).

The laboratory reports revealed 3,860,000 red cells and 75 per cent hæmoglobin, a moderate secondary anæmia. Urine analysis was negative. An X-ray film taken of both tibias revealed no pathological findings. The Wassermann and Kahn reactions were negative. Patient was a Type II.

On July 31, 1929, under nitrous oxide and ether anæsthesia a long incision was made on the lateral aspect of the thigh. There was profuse bleeding from small skin vessels. A very large, anomalous vessel was encountered below the superficial fascia. It was thick, did not seem to pulsate but had the size of about the common iliac artery, running parallel to the long axis of the limb (Fig. 12). It gave numerous branches medially and laterally which were clamped and tied. About an hour after the operation was started the patient's pulse became rapid and weak. She had obviously lost too much blood. The operation was rapidly completed, the incision terminating at the knee. Camphor oil was administered in the operating room. Dextrose and salt solution were given intravenously and under the skin. The red cells had dropped to 2,700,000 the next day with a hæmoglobin of 61 per cent. The healing of the wound was uneventful. On a high caloric diet with 200 grams of liver and 4 grams of ammonium ferric citrate, her red count rose to 4,510,000 on August 19, 1931, with 70 per cent hæmoglobin. She was discharged with a completely healed incision and an elastic bandage. It was thought of continuing the operation at a later period.

From September 1, 1929, to January 5, 1931, patient visited the Northwestern University Clinic every 2 or 3 weeks. The function of the leg was much improved. Repeated attempts were made to obliterate the venous dilatations on the dorsum of the foot and ankle by strongly irritating solutions such as 10 per cent quinine, 30 per cent sodium chloride, and 95 per cent alcohol. It was impossible, however, to obtain any obliteration with these solutions because of the presence of the strong back pressure from above.

On January 5, 1931, patient was admitted to Wesley Memorial Hospital, with a profuse hæmorrhage from one of the ruptured capillary angiomata at knee level. The bleeding was easily controlled by compression. On the following day, under nitrous oxide anæsthesia, the previous incision was continued distally from the knee to the ankle, the bleeding capillary angioma being excised. Just below the superficial fascia, the same anomalous vessel was encountered, in close proximity to the common peroneal nerve. The vessel had numerous branches which extended under the fascia into the muscles. It apparently carried non-pulsating, cyanotic blood. No communication with the arterial tree was found at this level. About 1½ hours after the beginning of the operation, patient again went into shock and the wound was rapidly closed with interrupted silkworm gut sutures. The blood pressure dropped to 80-0. The head end of the bed was elevated, 500 cubic centimeters of 6 per cent gum acacia solution was given intravenously. At the completion of the infusion, the blood pressure rose to 120-60. Patient had a chill lasting 5 minutes immediately after the infusion. She recovered rapidly from the shock. On the fourth day following the operation a very painful, itching urticaria developed, which faded fast but recurred on the eighth day. It was accompanied by a rise of temperature and interpreted as an anaphylactoid reaction to gum acacia. On January 25, 1931, patient received an Unna's boot and was discharged for ambulatory treatment.

At the third admission on March 25, 1931, patient complained chiefly of an increasing swelling of the ankle and dilatations of blood vessels on the dorsum of the foot. The tip of the fifth toe was cyanotic, the surface temperature being only 26 degrees C. There was also a motor and sensory paralysis of the peroneal nerve, with increased heat over the anæsthetic area. As the nutrition of the foot was not very good, it was hoped that with the next operation the terminal portion of the anomalous vessel could be removed. On March 28, 1931, the vessel was again exposed at the external malleolus and a curved incision was made over the dorsum of the foot. A skin flap was lifted up with a lateral pedicle. The vessel was again identified just below the tense lateral ligament and the latter was divided. Many small vessels, branching from the large vessel, were tied with fine catgut. A small exploratory incision was also made on the mesial side of the foot but no further vessels were found there. The lateral ligament of the ankle joint was carefully repaired and the skin was united with interrupted silkworm gut.

Eleven days later, under spinal anæsthesia, an incision was made in the popliteal fossa, slightly lateral to the midline. There was considerable bleeding from the subcutaneous tissue. The scar from previous operations was very heavy. The posterior tibial nerve was exposed and followed distally. It was found to be intact and nowhere adherent to the scar. The anterior tibial nerve (peroneal nerve) was imbedded in heavy scar tissue from which it was freed. A segment of 2½ inches had undergone a complete fibrosis; the nerve bundles on cross section were hardly visible. In all probability, this part of the nerve was caught in ligature or it was the result of an organized hæmatoma. This part of the nerve was dissected free and well mobilized proximally and distally. Slices of the proximal and distal stump were taken, until the cross section of the nerve looked normal. This left a large gap between the stumps, which could be bridged only by a 90 degree flexion of the knee. As the destruction of the nerve had occurred at the division into the superficial and deep branch, the two distal

branches had to be implanted into the proximal stump. Fine paraffinated black silk sutures were used, only the perineurium being caught. Fine interrupted catgut sutures were used to cover the nerve suture. Skin was closed with interrupted silkworm gut. A plaster-of-paris splint was applied on extensor surface of limb to maintain flexion.

There was some oozing after the operation but the wound healed by primary intention. The splint was removed on the tenth day, and slowly extension was permitted. The red cell count was down to 3,420,000 with 55 per cent hæmoglobin. From 15 to 20 cubic centimeters of blood were injected intramuscularly every second day, four times, which rapidly improved the blood picture. She was discharged on April 28, 1931, with 4,627,000 red cells and a hæmoglobin of 67 per cent. X-ray treatment of the miliary cutaneous angiomata has been started.

The histological report of the anomalous vessel, which was excised in three successive stages, follows (Dr. S. Vaughan). The specimen is a 13 centimeter segment of blood vessel, the diameter of which is from 6 to 8 millimeters (Fig. 13). The wall varies from 1 to 2 millimeters in thickness. There are no calcium deposits, and the lumen is filled with a blood clot. Under the microscope a large vessel with an irregularly thick wall is seen. This is of a peculiar appearance and has the thickness of an artery but is poorly divided into layers. The media adjacent to the intima contains a large number of longitudinal muscle fibers. No elastic membrane is seen. The lumen is almost completely occluded by a large thrombus which shows organization in places. Diagnosis: a large, atypical and thrombotic vessel (Fig. 14).

Summary. A 16 year old girl, who was born with a large vascular nævus on the lateral aspect of the left thigh and leg, first noticed swollen vessels on the lateral aspect of the left thigh at the age of 10 years. There were repeated hæmorrhages from small cutaneous vessels. She was given several treatments of radium and X-ray with no results. On three successive operations a large anomalous vessel, which was not recognizable before operation, was removed from the thigh down to the dorsum of the foot. Histologically it proved to be an undifferentiated vessel, mostly occluded by a thrombus. A nerve injury, which followed the second operation was also repaired. The small cutaneous angiomata, which bled readily, were subjected to X-ray treatment. The progress is definitely arrested, the limb is longer, and slightly œdemateous, but has good function.

CASE 5. Mrs. M. L., aged 42 years, was only examined and treated at the Northwestern University Clinic and therefore no intensive study was possible. In the left popliteal fossa a spongy, vascular mass has been present, as long as she can remember. This was diagnosed as varicose veins, and repeatedly injected by her physician, without success. On examination multiple tortuous vessels were seen, occupying an area of 5 by 4 centimeters, in the left popliteal fossa. There seemed to be no pulsation in this mass, but it could be readily emptied on pressure and seemed to fill up from below. There was no visible enlargement of the major or minor saphenous vein. Blood aspirated from a vessel was bright red, oxygenated blood, but the oxygen content of the blood was not determined. The whole mass was excised in the dispensary (Fig. 15) and the following histological report obtained: A large number of blood vessels were seen, with hardly more than a thickened endothelial lining. The endothelial cells were large and not quite regular. These minute vessels did not lend themselves to differentiation.

Summary. A 42 year old woman had a localized vascular mass in the left popliteal fossa, ever since she could remember. This was treated with injections unsuccessfully. The excised mass showed a network of multiple endothelial sinuses, explaining the failure of injection treatment. It represents the retiform stage with an arrest of development.

The five cases presented here illustrate various types of anomalies occurring in peripheral vessels. Thus Case 4 presented multiple capillary angiomata, which are localized remnants of the primitive capillary net. Case 5 represents a later stage, a number of parallel vascular tubes which have not fused sufficiently. Case 3 also belongs to this stage, although a much more diffuse involvement of the left lower limb was seen. It was practically inoperable, but an arrest of the disease was possible. Case 1 showed an almost perfect separation of vessels with the exception of the anomalous communication in the palmar arch, whereas Cases 2 and 4 showed a persistent anomalous vessel, primitive in histological structure. The former was operated upon at an early stage with perfect restoration of function.

In studying these histories one cannot help coming to the conclusion that these vascular anomalies are recognizable at an early stage and that they all seemed to be aggravated at puberty. If allowed to progress or if treated with insufficient measures, they become practically inoperable as the vascular masses invade the muscles and may even extend into the bone marrow. Cases 2 and 5 have had early excision, and no sign of recurrence for over 2 years. The other cases have progressed to a stage where a full restoration of function cannot be expected. Nevertheless, a radical excision of the vascular masses, but chiefly the interruption of arteriovenous communications, helped to arrest the anomaly. These operations are extensive and should be performed in several stages. Shock occurred in both Cases 3 and 4, probably from the loss of blood. It seems wise to operate upon these patients in stages and under local anæsthesia. The 2 patients, who had involvement of the upper extremities, were operated upon under brachial plexus block, whereas the lower extremities can conveniently be anæsthetized with a low spinal anæsthesia, which has all the advantages of a spinal anæsthesia and none of the un-

toward complications of a high spinal block. The operations should all be done under a tourniquet which is removed before the wound is closed. The muscle fascia should always be opened and the subfascial plane inspected as in the advanced cases venous dilatations are frequently encountered under the fascia. In Case 3 a fascial window was excised as in a Kondoleon operation and the edges of the fascia had to be stitched with a hæmostatic mattress suture, so profuse was the bleeding.

The early recognition and an early radical incision of the vascular anomaly offers the best hope for cure. The early recognition, in the absence of thrills, which occur only at large communications will depend on (1) increased surface temperature on the affected side, because of increased blood supply, (2) lengthening of the limb—this is not always present, and chiefly (3) the presence of mixed (arteriovenous) blood in the vascular dilatations, as emphasized by George Brown. This may be recognized by the color of blood or exactly by determinations of oxygen content with the Van Slyke apparatus.

SUMMARY

Vascular growths of the extremities are not true angiomata but are all due to faulty development. The variations encountered and enumerated as angioma simplex, cavernous and racemose angioma, diffuse phlebectasia, and congenital arteriovenous fistula are all due to the various stages of development in which the aberration from the normal occurred. Five cases are presented which represent various stages of developmental arrest. The methods utilized in diagnosis are discussed.

The visualization of the feeding vessel with X-ray may lead the surgeon to a direct attack of the anomalous communication. Early radical excision supplemented in suitable cases with obliterative injections offers the best hope for permanent results.

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MANAGEMENT OF FRACTURE OF THE MANDIBLE

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FRACTURE of the mandible, though fairly frequent in the field of bone injury, is surprisingly uncommon under industrial conditions. During a period of 6 to 7 years, a survey of some 40,000 industrial cases presented only 16 fractures of the jaw bones, of which 6 were maxillary and 10 were limited to the mandible. This infrequency suggests the cause for the lack of standard management. Failure to apply certain fundamental requirements in the treatment of fractures of this bone very often leads to an unfortunate permanent handicap.

It is, therefore, the purpose of this paper to call attention to the principles of management, to a frequent complication of mandibular fracture, and to point out means of immobilization which are not only effective at the time but fulfill future physiological and cosmetic requirements.

SITE OF OCCURRENCE

This fracture is usually the result of direct trauma. Subjective symptoms and objective evidence of injury are well defined and will not be dwelt upon except to emphasize the need of X-ray detail in proper projection. Good X-ray work should never be omitted. As fracture of the mandible is often multiple and there may be two fracture lines in the same half of the mandible or in opposite sides, both a direct anteroposterior and an oblique lateral projection, with each side down, should be taken as a matter of routine. If a fracture of the vertical ramus is suspected, an added projection for detail of this ramus should be secured.

The most frequent site of fracture of the mandible is through the horizontal ramus in an area of relatively weak bone near the mental foramen. The fracture line is most often oblique. The second most frequent site is in the area opposite the third molar tooth and just anterior to the angular tuberosity. The simpler double fractures most often include both of these positions. Fractures through the angle, vertical ramus, and neck of the condylar process are not so rare as textbooks indicate. A fracture in some portion of the vertical ramus is a frequent complication of a more obvious anterior fracture with displacement. In case of fracture in the last mentioned position, search for such a second fracture always should be made, even in the absence of clinical suggestion. It is important because double fracture increases the likelihood of displacement. The mechanism of displacement of fragments is essentially a matter of muscle attachment and lines of unopposed force. Where complete fracture occurs through the body and the fracture line does not oppose displacement, the mylohyoid, digastric, geniohyoid, genioglossus, and platysma muscles depress the anterior fragment; while in general, the temporal, masseter, and internal pterygoid muscles elevate the posterior fragment.

TREATMENT

It may be considered as axiomatic that some form of dental or intra-oral fixation is necessary in every complete fracture of the mandible, even those without displacement. Nevertheless it is surprisingly common to find early treatment limited to the application of a Barton bandage or a related type of external appliance. Fractures that exhibit a good result with such care would do equally well with none at all. Opposing muscle pull with a resultant line of force at 90 degrees or more usually will effect displacement—if not in a gross sense, certainly to the degree that improper dental occlusion results.

Treatment in each case, whether conservative or radical, should achieve these three results: (1) bony union, (2) proper occlusion of the teeth, and (3) proper function of the mandible as a whole. The first is given universal recongition, the second more or less thought and attention, and the third commonly is overlooked.

1. *Bony union.* Bony union as a prime requisite in management of this fracture is fortunately not difficult to secure under average circumstances. Good functional union with little risk of displacement will usually obtain in 3 to 4 weeks in ordinary fractures, and in a parallel length of time in the more complex fractures. Union is favored by secure immobilization during early callus formation, by good apposition of fragments, and by aseptic conditions. Conversely, absence of these factors inhibits union. Because of the inherent tendency of this bone to heal rapidly it should be stressed that union in malposition, even with overriding of fragments, may be well advanced in 3 weeks. This situation would make manipulative reduction impossible

or, with less advanced union, would eliminate maintenance of reduction by intra-oral fixation. In double fractures or posterior fractures it becomes most important, therefore, to secure proper reduction and fixation at once. With advanced union in any serious grade of malposition, operative reduction becomes a necessity. Delayed union and non-union are not frequent in the mandible, but, when present, are the result of the same influences and factors which govern lack of bone repair in general.

2. Proper occlusion of the teeth. As a second principle in management, proper occlusion of the teeth should not be overlooked as a matter that can be passed by lightly for future correction by a competent orthodontist. The time consuming element is already considerable in the treatment of the more complex fractures, and all possible adjustment should be made during early treatment. From the objective standpoint there is no better guide to correct reduction and fixation than the relationship of the teeth. Most mandibular teeth are inclined to the oral side of their maxillary neighbors. The oral cusps of molars and premolars are mesial to the corresponding inner cusps of the upper teeth. Anteriorly the more common mechanism of occlusion finds the "bite" a closed one in which the lower incisors are directed in a plane slightly posterior to the superior incisors. It is but rarely that a perfect end-to-end occlusion is met anteriorly. The cusp erosion present on occlusional surfaces of maxillary and mandibular teeth demonstrates clearly the type of occlusion normal to that individual. In the presence of displacement, fixation that reapproximates this relationship is a sure criterion of accurate reduction of fragments. Extremely loose teeth, of course, are not to be taken as a guide in this sense. These simple orthodontic facts, though primarily a matter of expert concern, nevertheless should be known to the surgeon, as dental consultation and aid in outlying communities may not be available. Recognition of the type and mechanism of occlusion in the absence of the very best X-ray work is often the only certain guide toward efficient reduction and fixation.

3. Proper function of the mandible as a whole. Under the third requirement of management, the proper function of the mandible as a whole is emphasized as a prime motive for this paper. The mandible is formed by fusion of two symmetrical halves during the first or second year. In function the mandible is peculiar in having a double articular mechanism, connected by a long arc with a joint at each extreme of the bone. This arc, or fused ramus, is the only means of preserving symmetry or balanced joint motion. Constant parallelism of rotational axes is necessary at the temporomandibular articulations for this one bone to function as a unit with two joints. The mandible is motivated by a double set of identical muscles which are complementary and synergistic only when the bone functions as a whole. Each temporomandibular joint is a true arthrodial diarthrosis with a double compartment formed by an intra-articular meniscus interposed between the glenoid fossa and the condylar head. This arrangement, by capsular laxity, permits a double type of motion—a gliding motion in which the condyle partially luxates forward on the crest of the glenoid fossa, and a true hinge motion around an obliquely transverse axis. Though this generous range and character of motion exists for each joint, function is not possible without motion in both joints. It follows, therefore, that derangement altering the mechanical requirements in one joint must influence in varying degree the same requirements in the other joint. From these dynamic considerations it can be said that the elements of the mandible sharing each temporomandibular joint, notably the condyle and vertical ramus, must maintain a constant and symmetric relationship on the two sides. Clinical demonstration proves that only the slightest alteration of this parallel position is compatible with the preservation of good joint function. A given unit of motion on a radius subtends a greater arc as this measured unit approaches the center, or a lessened central excursion as the same measured unit extends distally on the radius. The site of changed relationship in the mandible exerts a corresponding influence at the temporomandibular articulation. In other words, the more posterior the fracture and the closer to the center of joint action, the greater the influence of malalignment on joint relationship. It follows, therefore, that in posterior fracture with displacement, very accurate reduction of fragments is required to preserve temporomandibular joint function, and less margin of error is permissible than is the case in anterior fracture. Anatomically the short posterior fragment is also more easily displaced through the strong muscle pull of temporal and internal pterygoids.

Two cases are illustrated that demonstrate these considerations in a striking way.

Types of intra-oral fixation. Conservative treatment in the presence of teeth is condensed into two or three efficient methods of intra-oral fixation. Some form of interdental splint is the best method of fixation in severe fractures, in

cases of marked displacement, or with marked comminution of fragments. An orthodontic splint made from a plaster impression satisfies all requirements of treatment, and will often suffice as a permanent fixture until healing is complete. There is, of course, much practical difficulty in its early use. The preparation of such a splint demands experience and 2 days' time. This, for obvious reasons, may be impossible under conditions in which a given fracture may occur. During this interval the more serious fractures with displacement are in a process of repair in malposition with increasing deformity. Therefore, when at all possible, immediate fixation of fragments should be secured. For the average mandibular fracture, ligation of the teeth through one means or another should be carried out, the criteria for accurate reduction being kept in mind.

In bilateral or difficult fractures the application of Hammond's apparatus is quite serviceable and secure. This consists of malleable wire encircled around the last molars with a continuous band on both labial and oral surfaces. This requires considerable skill to mold properly and fit securely before cross-wiring through the interproximal spaces. One or two recently devised patent splints are also quite serviceable. These are adjustable to the contour of the teeth on the labial side and are attached to the teeth by wiring. One splint is attached to each jaw and then the mandible is immobilized by wiring these splints together securely. However, such splints are not by any means foolproof, and, unless carefully applied, will not guarantee accurate reduction. The choice of a splint will be determined by the type of fracture at hand.

In the majority of mandibular fractures some form of dental ligation is most practical for immediate fixation and is even preferable to any form of splint, both from the ease of application and from the absence of false reliance on complex methods of splint. wiring. Interdental splints, unless most accurately applied, often cover cusp surfaces and when removed there may be considerable mal-occlusion. Ligation, when neatly and effectively performed, leaves a clear view of dental occlusion, allows easy replacement and adjustment, and permits better hygiene of the mouth and teeth.

A method that I have employed quite satisfactorily is that devised by Oliver, modified and described by R. H. Ivy (Figs. 1 to 7). With a little practice, any surgeon should be able to use this method effectively. The wire used should be strong, yet malleable, and of such a size that it will pass freely in the space between the neck of the teeth. Two kinds of wire are recommended, No. 22 to 23 gauge copper wire, and the larger size, No. 24 to 26 gauge Angle's brass ligature wire. These are obtainable in any dental supply house. In emergency, soft iron or silver wire may be used. A fine steel orthodontic ligature wire 0.5 millimeter thick with non-corrosive properties is ideal, but not yet obtainable in supply houses. In applying wire ligation of the teeth, the instruments needed are a pair of blunt, short blade scissors (Crown and Collar), a towel clamp, and wire forceps.

The method of application is demonstrated in Figures 1 to 7. Before applying the wire to the teeth a 4 or 5 inch length is doubled around closed hæmostat blades and the long ends are twisted to form an eyelet about 2 millimeters in diameter. Both long ends are passed through an interspace selected, leaving the eyelet on the labial side of the interspace. The ends are then separated and passed from the oral side outward around the neck of each neighboring tooth, the eyelet being held in place with the towel clamp. The ends are then gathered and twisted securely under the eyelet on the upper teeth and above the eyelet on the lowers. Both eyelets then are engaged with a short length of separate wire, and this is twisted sufficiently to effect firm traction between the upper and lower eyelets. All free ends are cut short and bent laterally to avoid mucous membrane irritation. Selected teeth on the opposite side, or incisor area, are then bound in similar fashion. This ligation with eyelet anchorage may be applied to a single tooth. The position of the eyelet may be so fashioned, in relation to the upper or lower teeth, that an oblique pull may be secured where needed. Several interspaces between uppers and lowers may likewise be omitted to produce an extremely oblique pull. Through this type of ligation, immediate reduction often may be effected. Tightening and adjustment of the connecting ligatures will most often be needed after 24 hours, and periodically thereafter. Should a connecting wire ligature break it may be replaced easily without disturbing the eyelets.

A more substantial type of fixation is the application of either permanent or removable orthodontic bands to individual teeth. The permanent bands require a day or more to apply, but are most satisfactory when such delay is not prohibitive. Removable orthodontic bands for individual teeth are procurable at supply houses, and may be applied easily with little practice. Both the latter and permanent bands have a hook or fastening projection on the labial side for

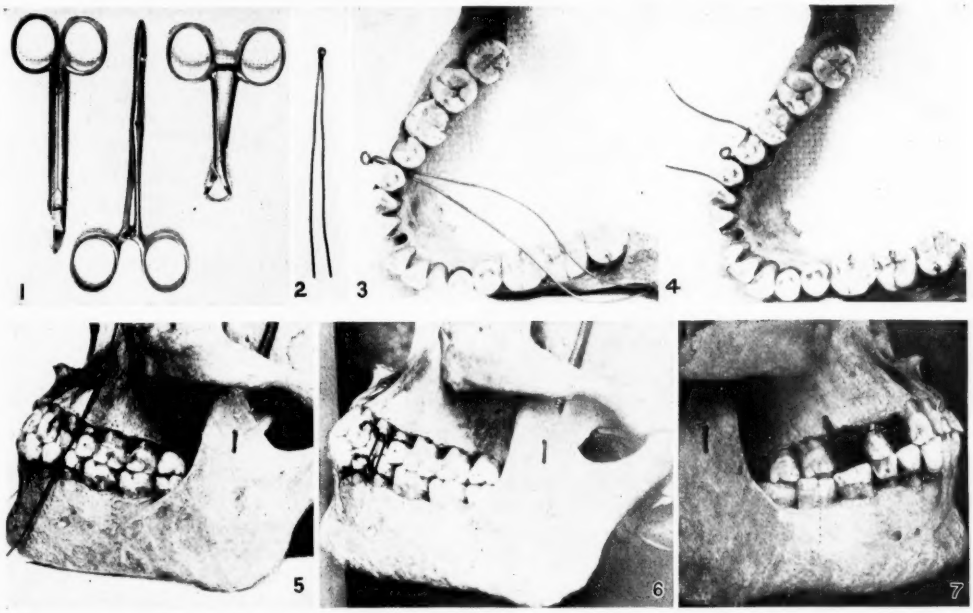

Fig. 1. Instruments required for manipulating wire; towel clamp, hæmostatic forceps, and short-nosed scissors.
Fig. 2. Wire twisted to form eyelet.
Fig. 3. Ends of eyelet wire inserted between premolar teeth.
Fig. 4. Ends of eyelet wire carried around premolar teeth back to buccal surface.
Fig. 5. Eyelet wires attached to upper and lower premolar teeth. Connecting wire passed through eyelets.
Fig. 6. Upper and lower teeth fixed in occlusion by connecting wire passed through eyelets. Ends of wires twisted, cut off, and bent over.
Fig. 7. Eyelet wire attached to single tooth in upper jaw.

(Figures 1 to 7 from Ivy, Surg., Gynec. & Obst.)

ligation between the two jaws. By the use of bands there is much less tendency toward slipping or breaking of connecting wire ligatures, and larger wire may be used.

Fractures of the mandible, as in all bone fractures between muscle origin and insertion, have little or no tendency toward linear separation. Where this does obtain through comminution or loss of substance, traction or fixation in the long axis of the bone may be effected equally well by separate wire ligatures between the bands, or between the eyelets of the wire method of Oliver and Ivy. Moderately loosened teeth should not be extracted at once, as they may again become fixed.

General considerations. General measures should be directed toward careful and constant mouth hygiene. Many mandibular fractures are compound in the sense of perforating the buccal cavity or extending into the summit of an alveolar process. In either case such a fracture is potentially septic. In addition to an alkaline mouth wash at hourly intervals the teeth should be cleansed with a soft brush or cotton applicator, and a mild cleansing lotion.

A long standing fetish has prevailed to the effect that immobilization of the mandible should not be completed until all danger of postanæsthetic vomiting has passed. To await such a time presents local difficulties in securing the most accurate reduction and occlusion. In a series of 18 cases of immediate fixation of the mandible under general anæsthesia, there has been no difficulty from vomiting or pulmonary complication. In fact, in but 2 instances did vomiting occur at all. The depth of anæsthesia for this work need not be great. Solid food should be withheld for 12 hours prior to operation. Any vomiting that occurs will, therefore, consist of liquid gastric content which is passed easily around the posterior molars and through the interspaces of the teeth. Before recovering consciousness or reflexes, the patient should be placed in a ventral prone position without head pillows. A nurse or trained

Fig. 8. Case A.P. Fracture with marked displacement left premental area.

attendant should be present constantly while vomiting may last. If urgent difficulty occurs from vomiting, the wire ligatures can be cut instantly. Local anæsthesia is applicable occasionally, but I do not advise its routine use, since most manipulative work is bilateral and often in a potentially infected field.

LATE TREATMENT

Late treatment deals with the failure to secure fundamental requirements. In severe fractures this is often unavoidable. Late or final treatment is directed along two lines. The first is

Fig. 9, left. Case A.P. Flattening and depression left horizontal ramus. Rotation ascending ramus and restriction mandibular movement.

Fig. 10. Case A.P. Limitation mandibular excursion. Marked dislocation of teeth.

Fig. 11. Case S.A. Mal-union 7 weeks after injury. Fracture left premental area. Right angle. Note deviation of jaw to left. Mal-occlusion. Thickness right ascending ramus, denoting rotation of this ramus.

surgical correction because of mal-union, non-union, or osteomyelitis. In any of these complications, operative care is required. Surgical correction of complicated late cases forms an interesting technical field, but will not be discussed in this paper. The second consideration in late treatment is dental reconstruction of injured or missing teeth and orthodontic correction of displacements. In any case a competent dentist should examine the teeth toward final adjustment.

COMPLICATIONS

Complications may be early or remote. In the recent case, fracture of the base of the skull or neighboring facial bones should be kept in mind. With a severe fracture, compounding of one or both fragments into the oral cavity may occur.

Fig. 12. Case S.A. Right mandible with fracture near angle, apparently in good position. Actually much displacement with rotation of posterior fragment (ascending ramus).

Fig. 13. Case S.A. Postoperative correction with union. Note re-alignment of right ascending ramus.

The fracture line often extends into an alveolar process surrounding the apex of a tooth. Both of these situations invite infection. In either case early infection of soft tissues may occur. Fortunately, true bone infection does not occur often. When osteomyelitis occurs, surgical intervention is necessary either externally or through the mouth, as may be indicated by the site and extent of bone involvement. In fractures entering an alveolar process alone, or extending to the oral mucous membrane, bony union without infection often occurs. If this happens in mal-position, operative correction is accompanied usually by infection.

Broken, loosened, or displaced teeth adjoining the fracture line are common. Severe hæmorrhage occasionally is present in marked injury.

Late complications. Osteomyelitis, local or diffuse, is, fortunately, uncommon. Non-union complicates gunshot injuries with loss of substance, and is comparatively rare in other types of mandibular fracture. Mal-occlusion is a very frequent complication in even simpler cases. Devitalized teeth occur when the fracture line includes the apex of the alveolar cavity of such teeth. These should, however, be distinguished from loose teeth which are not necessarily devitalized. Mal-union of the mandible results in changed dynamics of this bone as a whole. When displacement is not accurately reduced the ascending ramus rotates on a vertical axis. This rotation results in derangement in one or both temporomandibular joints, which is expressed clinically in terms of local pain at these joints and limitation of mandibular excursion in opening the mouth.

Fig. 14. Case S.A. Mal-occlusion. Orthodontic bands in place for fixation after operation. Mouth opening limited to ¼ of an inch, with marked discomfort both temporomandibular joints.

In opening, the mandible may deviate to the affected side. Late traumatic arthritis of the temporomandibular joint often complicates posterior fracture. Occasionally, fractures involving the condylar process result in ankylosis of the corresponding temporomandibular joint.

SUMMARY

1. Double fracture of the mandible is common. Search for a second fracture always should be made.

2. Three X-ray projections should be secured routinely.

3. Treatment should have as its goal a result that fulfills three requirements: (1) bony union, (2) proper occlusion of the teeth, and (3) proper function of the mandible as a whole.

4. Accurate reduction with intra-oral fixation of fragments should be effected promptly.

5. Moderately loose teeth should not be extracted; they may become firmly fixed as repair proceeds.

6. Dental attention should be given during and after union.

7. Severe mal-union, non-union, and bone infection require operative care.

8. Rotation of the ascending ramus complicates fractures with displacement. Union in mal-position with such rotation of the ascending ramus gives rise to permanent derangement of temporomandibular joints and impaired function of the mandible as a whole.

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SOLID PURE FIBROMA OF THE MESENTERY IN CHILDREN

J. E. SUMMERS, M.D., F.A.C.S., OMAHA, NEBRASKA

A REFERENCE to the literature on solid tumors of the mesentery indicates that the finding of pure fibromata has been a rare occurrence, especially among children. The following case is of interest therefore.

A healthy appearing, bright little, three year old girl was sent to me for an opinion June 25, 1931, by Dr. John P. Gilligan, Nebraska City. The history was that about one month earlier the mother while bathing the child detected a small tumor of the abdomen. Every day the tumor seemed to be felt in a different location, and, as it had grown considerably since first noticed, the mother consulted her physician.

There was nothing unusual in any way in the family history or that of the child. She had always been healthy. The tumor felt to be about the size of a new potato, was hard and very movable, could be pushed into any quarter of the abdomen, most easily under the left costal arch. The absence of tenderness and fixation and the high mobility could only classify the tumor as one of the mesentery, away from either end and somewhere toward its center. I was inclined to regard it as a sarcoma, considering the age of the patient and the rapid growth of the tumor. Early operation was advised. This was carried out at St. Mary's Hospital, Nebraska City, Dr. Gilligan assisting and in charge of the after care.

The tumor was situated in the mesentery of the lower jejunum, free from adhesions, and was with little difficulty peeled out. It had an intact, thin capsule. There was some trouble in controlling the oozing and obliterating the cavity from which the growth had been removed. The convalescence was normal and the child was taken home in 10 days. The nature of the growth, a pure solid fibroma, promises a non-recurrence.

Pathological report. Sections of the tumor showed it to consist of irregularly interlacing bands of cells, all of which appeared to be of rather uniform type, considerably elongated spindles, with relatively little cytoplasm, most of the internuclear material being fibrillar in character. The distribution of the cells in interweaving bands suggested a myofibromatous character, but differential staining failed to reveal the presence of muscular elements. Nowhere was there apparent evidence of unduly unrestrained or lawless growth.

Diagnosis: hard fibroma. (Drs. Eggers and Dunn, Pathological Laboratory of the University of Nebraska College of Medicine.)

In January, 1897, Harris and Herzog, reporting a solid mesenteric tumor referred to 65 additional cases, of which only 5 were in children from 1 to 10 years of age. Of the children's cases all were mixed types of tumor—no fibromata, of the adults only 2 fibromata.

W. H. Greer, in 1911, reported in a summary of 33 mesenteric tumors one pure fibroma in a child, operated upon by Folet; in a girl 10 years of age, a tumor about the size of two fists was casually discovered. The tumor was enucleated and the wound closed. The growth was attached between the folds of the mesentery. It was a fibroma and weighed 4 pounds. Patient recovered. Two other children in this list had mixed types of tumors.

Dr. Alfred Szenes, in 1918, in his report of 60 cases of solid mesenteric tumors, also mentions the case of the small girl referred to by Greer. Three other children were cited as cases in which sarcomatous tumors were found. Eighteen of the 60 cases were fibromata. None other than Greer's was a pure fibroma among the children. Many of his cases are to be found among the lists of Harris and Herzog, and Greer.

E. S. Judd, and J. R. McVay, of the Mayo Clinic, in 1919, reported a case of fibromyoma of the mesentery in a woman 25 years of age. They do not list any other cases from the clinic and make no reference to children. Their paper gives a short résumé of the works of Harris and Herzog, Bowers, Greer, and Bigelow and Forman, only one of whom, Greer, refers to the case of a pure fibroma in a child. In concluding they say, "undoubtedly earlier diagnosis and operation will aid materially in lowering the mortality."

"Fibromata of the Mesentery with the Report of a Case," was the title of the paper written by J. L. Decourcy and J. J. Maloney, of Cincinnati, in 1925. They refer to Greer, Morgagni, Sydenham, Bevan, Kyle, and Sir Bland-Sutton. In their summary of fibromatous mesenteric tumors —40 cases occurring in the last 100 years—these three points were brought out: (1) uncommon occurrence; (2) diagnosis difficult; (3) surgical treatment consists of enucleation with or without resection as seems indicated by conditions found.

In his book *The Abdominal Surgery of Children*, published in 1928, L. E. Barrington-Ward, writing about solid tumors of the mesentery in children, states that fibroma, sarcoma, and lymphosarcoma occur very rarely. He mentions the cases collected by Greer, also the one of a boy 3 years of age—nature of tumor not stated—by Cannon and O'Kelly, and a girl of 8, teratoma of the mesentery, by Jennings Marshall.

"Mesenteric tumors are comparatively rare," writes W. H. Fisher, in an article reporting a case of fibromyoma. He mentions 100 cases collected by Bigelow and Forman, one of which was a lymphosarcoma found in a boy of 6. Harris and Herzog, and Szenes were also referred to.

Fig. 1. Tumor, actual size. Cross section of tumor. Weight 72 grams. 6½ inches circumference.

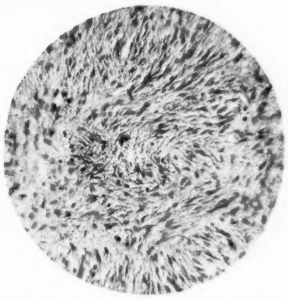

Fig. 2. Photomicrograph of tumor.

J. P. Tourneux, in 1929, reporting the case of a pure fibroma found in a man of 48, says: "A pure fibroma, a single tumor, is by no means uncommon in the mesentery (referring to adults). Its presence is often recognized by the patient long before any symptoms occur; and early diagnosis and operation is imperative as this is the tumor which, as age advances, is apt to assume the serious character of a spindle-cell sarcoma."

A research of the bibliography on solid mesenteric tumors discloses but one case of pure fibroma of the mesentery in a child, the one listed by Greer and operated upon by Folet. Many of the mesenteric tumors are repetitions of those already reported by Harris and Herzog, Greer, and Szenes. Out of these lists, 128 cases have been taken as acutal ones on which to base our findings. In all of these 128 cases only 16 pure fibromas were found; 7 in women, 4 in men, 4 no data given, and 1 found in a child 10 years of age. Twelve were operated upon, 8 recovered; and in 4 cases no data were given. Mesenteric tumors were found in children as follows: fibroma (Greer's and personal case), 2; lymphosarcoma, 3; round celled sarcoma, 2; teratoma, 1; fibrous tissue, fat, cartilage, calcareous material, 1; malignant lymphoma, 1; lipoma, 1; fibromyxoma, 1; multiple fibromata, 1; angio-sarcoma, 1; no data given, 2; total, 16.

Results: died, 6; recovered, 5; no data given, 5; total, 16.

CONCLUSIONS

A careful study of the literature, to which only brief reference has been made, establishes the rarity of the occurrence of solid fibromatous tumors of the mesentery in children. The case here reported, is seemingly the second observed; of course, others may not have been recorded.

The writer desires to emphasize the fact hat all tumors of the mesentery whether simple cysts, multilocular cysts, or solid tumors, should be operated upon early, and should be treated by marsupialization (the cysts), or enucleation-excision, whenever this is practicable. The writer's personal experience of 4 patients operated upon, three reported (14), indicates the wisdom of this practice. Seldom is it necessary to excise the intestine forming the periphery of the tumor, although it may seemingly be so. Such practice adds materially to the danger of operation. Reference to the writer's (14) papers will tell of the technique by which resection of the intestine may in some instances at least, be avoided, and when carried out the danger minimized (15). Anastomosis clamps such as those of Dowd, Rankin, and Partipilo will add much in reducing the mortality in intestinal resection.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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AUGUST, 1932

THE FATAL ACUTE APPENDIX

AMID the remarkable advances in abdominal surgery, with its steadily decreasing mortality in major procedures, it is disquieting to be faced year by year with a rising death rate in acute diseases of the appendix. We know that a timely operation means practically no mortality. The facilities for dealing with acute abdominal emergencies —hospitals, transport, etc.—have improved year by year and the number of trained surgeons has increased *pari passu*. The public, therefore, has a right to expect a falling death rate in a malady which lends itself conspicuously to cure by surgery.

There must be some valid reason for the maintenance of a high mortality rate in spite of the great increase in surgical activity in dealing with this type of emergency. "Early operation in acute appendicitis" is now a dictum with almost every trained practitioner of medicine.

The reason for the ineffectiveness of all our efforts lies in the failure by the profession at large to appreciate the true pathology of the dangerous type of case. Thus while the physician submits many genuine but mild cases of acute appendicitis to early operation he, from a faulty knowledge of pathology, tends to delay over the case in which operation is not only an advisable but in fact a life saving measure.

Over twenty years ago Van Zwaluwenburg, of Riverside, California, pointed out of what vital importance was obstruction of the lumen of the appendix in producing a fulminating attack of appendicitis. His work, which was published in local journals, has never received the attention or credit which it so justly deserves.

We now know that acute disease of the appendix may, broadly speaking, be one of two types. It may be either an infective inflammation of the wall of the organ, of itself a relatively harmless disease, or it may be a sudden obstruction of the lumen of the organ which, under certain conditions, may prove a rapidly fatal disease.

The first—true appendicitis—is associated with a clinical picture such as one would expect from an inflammatory lesion present within the abdomen, viz., rise in pulse rate and temperature, vomiting, aching pain, and local tenderness. Few could fail to diagnose this type. The second, acute appendicular obstruction, gives the clinical picture of an acute intestinal obstruction, viz., sudden onset, spasms of pain, vomiting, but no initial rise of pulse rate or temperature.

It is the pathology of the first few hours of acute appendicular disease which we must study. It is at this stage that the two types—inflammatory and obstructive—stand out clear cut and well defined.

Investigations have revealed the fact that over 90 per cent of the deaths are in the obstructive group of case. It is the duty of surgical teachers, therefore, to make abundantly clear to students and doctors, and through them to the public, that sudden recurring abdominal colic, associated with vomiting but unattended with any rise in pulse rate or temperature, may indicate the most severe form of acute disease of the appendix. It is more urgent than any form of intestinal obstruction excepting internal strangulation, because it is of the closed loop variety and tension gangrene of the wall develops early, particularly if fæcal matter be present in some quantity at the moment of obstruction. The administration of a purgative will accelerate the tension gangrene and precipitate perforation. The public must be informed that abdominal colic demands medical advice, not purgation.

The removal of an acutely obstructed appendix, even gangrenous but unruptured, is unattended by appreciable risk. The rupture of such an appendix, with the resultant spilling of its fæculent content into the free peritoneal cavity, leads to a grave peritonitis, frequently fatal in spite of operation. The diagnosis and removal of an acutely obstructed appendix, unperforated, is a triumph of medicine. Operation after perforation has occurred is but an inadequate effort to repair the evil results which have been caused by delay or mismanagement.

An intelligent appreciation of the pathology and related clinical pictures of the two fundamentally different types of acute disease of the appendix, first by teachers, and through them by students, doctors and, finally, the lay public, will do much to bring the dangerous obstructive cases early and thus to lower the death rate from acute peritonitis and its sequelæ.

D. P. D. Wilkie.

RENAL PTOSIS

IT would hardly seem necessary to reopen a subject for discussion which has been settled and buried several times in the last 30 years. Yet, when it is resurrected with somewhat altered features, and set going again with new supporters and followers, it must be dealt with and either reinterred or allowed to go on its way. Surgery for movable kidney has had such a course in recent years and is now enjoying a decided renaissance. Many of the arguments in its favor are not new and consist of the simple story of nephroptosis detectable by palpation, abdominal pain, nephropexy, and cure, at least when so reported from 3 to 6 months later.

The experience of 20 odd years ago, when the operation was widely employed, is surely not forgotten. Many surgeons were enthusiastic about the merits of nephropexy, and cures were claimed as a result of it in a great variety of complaints and conditions, varying from backache to insanity. When symptoms, either similar or referred to other regions, even to the other kidney, reappeared in many cases within a year or more afterward, the operation soon lost its appeal, was largely discontinued, and fell into disrepute. In recent years, renal fixation has been revived by the urologists and we now find that it is spreading rapidly. The question naturally arises: What reasons are there for revival of this procedure? Has any new or overlooked reason for it been found, any new method of diagnosis, any recent discovery in pathology or physiology to substantiate it, and lastly, has a new method of operation been discovered, which not alone fixes the kidney permanently, but the symptoms as well?

The present attitude toward surgical treatment of nephroptosis varies widely. There are the two extreme views, one that surgical

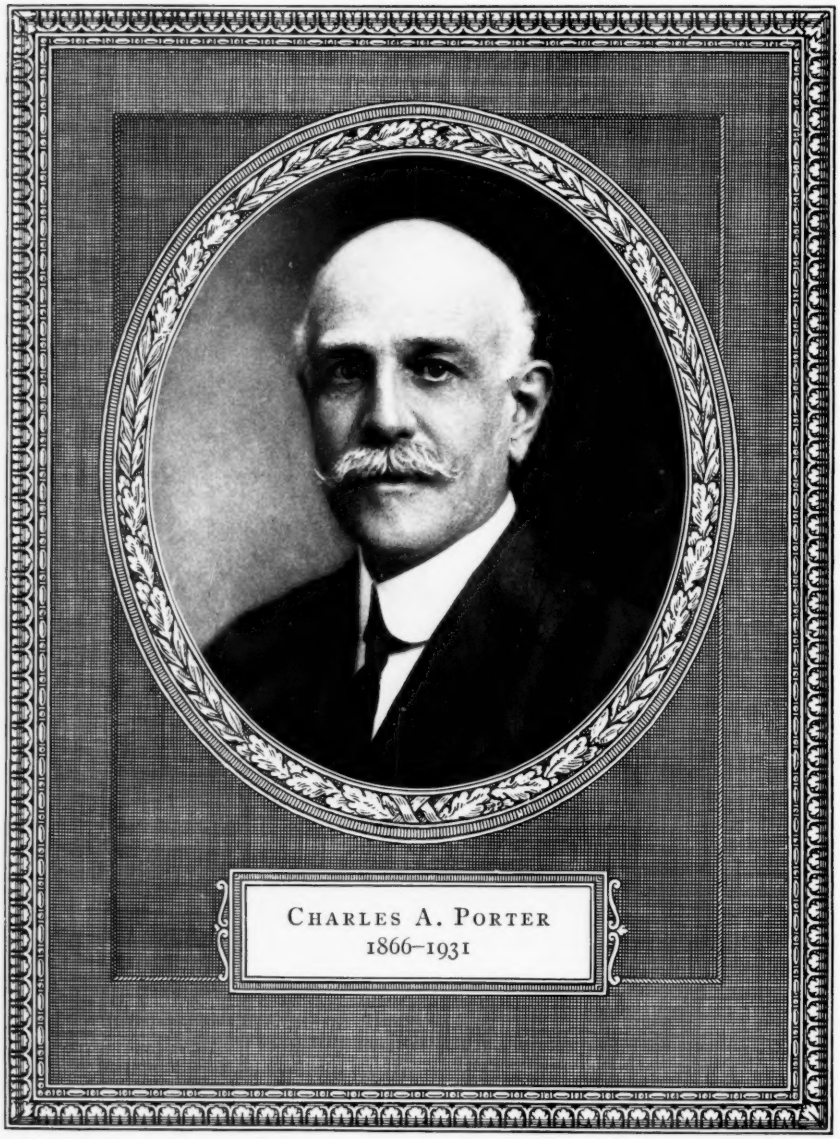
treatment is never indicated, and the other that in most cases of nephroptosis surgical treatment should be applied. There is a third group, the members of which believe that nephropexy is indicated in selected cases only. Its members differ widely, however, as to methods of selection and as to the proportion of patients who should be operated on. The more liberal members of the third group would include many cases with symptoms referred to the kidney, whether or not they found any evidence of pyelectasis or urinary retention on urography. They manage to find a considerable proportion of the patients with nephroptosis who are amenable to nephropexy. The conservative element in this group, however, will insist on definite urographic evidence of renal obstruction, as well as pain referred to the renal region, before advising surgical treatment.

The degree of ptosis visualized in the urogram should not be regarded as an indication for operation. Pyelectasis and renal stasis are the only factors which should influence judgment. The importance of correct interpretation of the urogram is evident in the selection of patients for nephropexy. In extreme cases pyelectasis is easily recognizable. The recognition of a slight degree of pyelectasis, however, may be difficult, and the personal equation may be a large factor. To complicate matters, a slight degree of pyelectasis may be present which is not the result of obstruction, but which is due to an atonic condition of the wall of the pelvis or of the ureter. Such a condition may be the result of a previous renal infection and may not be influenced by renal fixation. In cases about which there is any doubt, the existence of stasis may best be determined by means of pyeloscopy.

Symptoms also are significant. Unfortunately, in most cases of renal ptosis the symptoms are not at all typical of renal pain and are frequently masked by complaints which are clearly of a functional type. The pain is often referred to various areas in the abdomen and seldom resembles the clear cut colic usually observed with renal obstruction. In many cases the symptoms can be explained by an inferior nervous system and there is often definite clinical evidence of hysteria, psychoneurosis, or constitutional inferiority. In seeking relief from symptoms, these patients will grasp at any suggestion of organic lesion, and will readily permit surgical treatment when so advised. Most of the patients examined will have had several abdominal operations performed without relief.

It must be admitted that nephropexy in cases in which there is no evidence of renal stasis may be followed in some instances by relief of symptoms for a variable period. No reliance, however, can be placed on subjective relief following operation unless a year or more has elapsed. At the end of this time, the symptoms in most cases either will have returned, or other symptoms of a similar nature will have taken their place. It is of greatest importance that urographic studies be made following nephropexy, in order to determine the results accomplished. If renal stasis was caused by nephroptosis, evidence of pyelectasis should either be reduced or entirely eliminated. Clinical examination of a considerable number of patients observed several years after having been operated on by various surgeons for nephroptosis would lead one to conclude that the number of patients with renal ptosis that are amenable to relief by renal fixation will be comparatively small. Renal fixation, without regard to any evidence of renal obstruction, as is frequently being carried out, is to be deplored.

WILLIAM F. BRAASCH, M.D.



CHARLES A. PORTER
1866–1931

MASTER SURGEONS OF AMERICA

CHARLES ALLEN PORTER

ON July 3, 1931, Dr. Porter, a leader in the surgical profession of our country, passed away. In his death we lost one of our most valuable members. He was born in Cambridge, Massachusetts, September 9, 1866, the son of Dr. Charles Burnham and Harriet A. (Allen) Porter. His ancestry was notable, particularly in relation to medicine. His earliest American forebear of whom there is record was Dr. Daniel Porter who came to this country early in the seventeenth century and settled in Farmington, Connecticut. His three sons continued the practice of medicine, two of them in Farmington and one in Waterbury. In the next generation there were also a number of physicians, one of whom, Dr. James Porter, 1745–1780, was a surgeon in the British Army during the Revolution. The medical tradition of the family did not die out and several other members of the family continued the practice of medicine in Rutland, Vermont. Dr. Porter's father, Dr. Charles Burnham Porter, was the son of Dr. James B. Porter and was born in Rutland in 1840, graduating from Harvard College in 1862, and later from the Harvard Medical School and Massachusetts General Hospital. He died in 1909, having been one of the most active and capable surgeons of his time, a demonstrator of anatomy under Oliver Wendell Holmes and an inspiring teacher in the medical school for nearly forty years. His son, the subject of this notice, followed closely and worthily in his father's footsteps. He was graduated from Harvard in 1888, took the then optional course of four years at the Harvard Medical School and, like his father, became a surgical house pupil at the Massachusetts General Hospital.

During his medical school days he never wavered in his interest for that branch of the profession which he later developed in such marked degree. At that time it was possible for students to spend most of the optional fourth year at the hospital, and this Dr. Porter did. He was already versed in the fundamentals of surgical practice before he had taken his degree and before he had had the more intensive training as a house-pupil. After leaving the hospital he forthwith became an assistant in anatomy, a subject in which naturally he had the keenest interest and a high degree of proficiency. In 1894, he was appointed surgeon to out patients at the Massachusetts General Hospital, and rose steadily through the various grades until he attained the position of surgeon in chief,

which he held for two years preceding his enforced retirement on account of the age limit at sixty. In 1896, he went to Europe, combining travel and study, and on his return was appointed an instructor in surgery at the Medical School. From this he advanced successively to assistant professor of surgery, 1909–1913; associate professor of surgery, 1913–1916; clinical professor of surgery, 1916–1918; professor of clinical surgery, 1918–1922, when he was appointed John Homans professor of surgery and became emeritus professor on his retirement from active teaching.

In 1915, he enlisted in the first Harvard Unit and served in English field hospitals, a reference to which appeared in the London *Times* of July 8.

His society membership was comprehensive. He was a fellow of the American College of Surgeons, the Society of Clinical Surgery, American Surgical Association, a member of the American Medical Association, Massachusetts Medical Society and the American Association for Cancer Research. His rank as lieutenant colonel in the Medical Corps of the Army made him eligible for the Military Order of the World War. He was also a member of the National Institution of Social Sciences and of many smaller societies in Boston and New England. He was at one time president of the New England Surgical Society and the Boston Surgical Society.

In college he was one of the best athletes in his class. He rowed in his class crew in his freshman year. He played several years on the football team, and was one of the best half-backs Harvard ever had. His friendly personality and his athletic prowess made him a great favorite with his classmates. He stood close to the head of his class in the medical school, and was the only student I ever knew who passed the examination in first year anatomy under Dr. Thomas Dwight with a mark of 100 per cent.

Dr. Edward Wyllys Taylor writes as follows regarding his work as teacher:

> "Dr. Porter was an admirable teacher, enthusiastic and convincing. He was much given to the use of homely illustrations to bring out technical points which served as more elaborate descriptions would not have done, to drive home the idea he wished to convey. He was rather dogmatic in statement which, dangerous as it may be under certain circumstances, finds ample justification in didactic teaching. He was extremely well read in surgery and took particular delight in studying and if possible operating on difficult and obscure cases. Nothing was too hazardous for him to undertake if he felt that surgical interference was justified. He was a skillful dissector even in his medical school days, which, carried over into the practical aspects of his later work, was naturally an asset of the greatest value. His courage in undertaking an operation from which many would shrink appealed to the students and to his colleagues in the same way that his physical courage on the football field in his college days had appealed to his teammates and opponents alike. Were one to attempt to state his outstanding characteristics, one would perhaps put moral and physical courage first, enthusiasm second and a boundless friendliness third, all happily combined in an unusually charm-

> ing personality. He was furthermore peculiarly approachable and quickly made friends with those with whom he came in contact whether as students or colleagues. As one of his younger associates expresses it, 'He was always available for advice or consultation on any surgical matter.'"

He was distinctly a man of action and like many such men found writing irksome and difficult. His literary output, therefore, was not so large as that of others with far fewer ideas to express. What he did publish bore the impress of careful work based on extensive experience. He was a pioneer on the subject of major sepsis and his painstaking work in skin grafting after X-ray burns will long be remembered by those upon whom he operated and by their friends. It will be recalled that literally for years he operated again and again upon the late Dr. Walter Dodd until finally the difficulty got beyond even his power to help. He was widely sought for the treatment of such burns, often a most discouraging task which, true to his temperament, he undertook with enthusiasm and carried out with infinite patience. He was also much interested in surgery of the peripheral nerves, especially in conjunction with the late Dr. Walter E. Paul, and he was one of the first at the Massachusetts General Hospital to operate on the thyroid gland.

A clear indication of the esteem in which he was held not only by his professional friends but by the community in general was shown by the large attendance at his funeral conducted by the Rev. Samuel Eliot at the Arlington Street Church. In his death a distinguished medical line, which has been unterrupted since the latter part of the seventeenth century, comes to an end, as was likewise the case in the Warren family through the death of Dr. John Warren, in 1928.

He married Dr. Margaret Cochran Dewar of Glasgow, Scotland, in 1898, who, with a son, Charles Burnham Porter, and two daughters, Miss Isabel DeCourcy, and Miss Margaret Dewar, Porter, survive him.

This brief notice cannot be closed better than in the concluding words of a notice published in the *American Journal of Roentgenology* by his friend and patient, Dr. Percy Brown:

> "'Allie' Porter, in his surgical warfare against the progressive ravages of profound X-ray burn, usually had a tough opponent in front of a sector onto which he had been brought up only after the resistant forces had become deeply entrenched, whereby he could not always attain his objective. Each new demand upon his skill, however, brought forth reinforcements of enthusiastic energy from sources apparently inexhaustible. Of his brilliant successes, impossible for one of less experience in this field of distinctive pathological phenomena, he spoke little in casual discussion. It remains for the fortunate beneficiaries of his proficiency to recount them, and to carry, in gratitude, the memory of his ministration and his friendship down the gentle gradient from Life's plateau."

FRED B. LUND.

EARLY AMERICAN MEDICAL SCHOOLS

THE ROCK ISLAND MEDICAL COLLEGE AND THE COLLEGE OF PHYSICIANS AND SURGEONS OF THE UPPER MISSISSIPPI

A. E. McEVERS, M.D., F.A.C.S., Rock Island, Illinois

THE autumn of 1848 marked the opening of the first session of the Rock Island Medical School. Dr. Moses L. Knapp was president and professor of materia medica and therapeutics. The following year, the college migrated to Davenport, Iowa, where it was known as the College of Physicians and Surgeons of the Upper Mississippi. In 1848 the Madison Medical College was incorporated by the Wisconsin legislature. In its charter, power was granted to create a branch. This was exercised in the organization of the Rock Island Medical School in Rock Island, Illinois. The Madison Medical College never functioned and the Rock Island branch apparently was its only activity; due probably to the fact that it was easier to secure a charter from the newly organized legislature in Wisconsin than in Illinois.

A course of lectures was given at Rock Island, beginning November 7, 1848, and on February 20, 1849, 21 students graduated. This was the only course given at Rock Island. A new corporation was secured in Iowa under the name of College of Physicians and Surgeons of the Upper Mississippi, located at Davenport, Iowa. In letters from John F. Dillon to George A. Bunker in June, 1849, as published in Zeuch's *History of Medical Practice in Illinois*, it is indicated that there were some difficulties in maintaining the school in Rock Island and the letter suggested that the anatomical question was a factor.

It was stated that the removal of the school from Rock Island to Davenport was due to the enterprise of Mr. John Forrest, of Davenport, who had erected a commodious building which was leased to the faculty for a term of years. The building is described as containing an amphitheater, lecture rooms, and dissecting rooms lighted from above. At the second session of the school, the faculty was reorganized. Pierce and Goudy dropped out, but Richards, Knapp, and Armor retained their subjects. Chapman assumed the chair of anatomy, Sanford had surgery added to his former subjects and Everts taught chemistry and pharmacy. J. D. Fisher was demonstrator of anatomy and A. S. Hudson was prosector to the chair of surgery and obstetrics.

The zeal of some designing men in finding bodies for dissection created some sort of dissatisfaction that affected the College. The shortage of cadavers literally created a new occupation. The teacher's desire for specimens outweighed their better judgment and anyone presenting the cadaver at the door, found a willing purchaser for it without questioning. In connection with this the following story is related:

> "The next day after a body had been left at the college, a man announced to the doctors that the family of the deceased was very angry over the disappearance of the body and this gentleman volunteered to relieve the doctors of the evidence, the finding of which most probably would bring about unpleasant complications. (Since the memory of rioting begun for a similar cause elsewhere was still fresh in the minds of the doctors, the body was surrendered). The man then secreted the body on an island and told the family that he could recover the body for a price. When the price was paid, the body was restored to the bereaved relatives who were relieved that the loved one had not been dissected."

One thing is quite certain, that the failure of the school was not due to poor teachers. It is apparent from letters written by Dillon that the professors were an able body of men.

The incorporators were George W. Richards, Moses L. Knapp, Chandler B. Chapman, John Y. Smith, Richard S. Maloney, and Nathaniel W. Dean. The first three were on the faculty of the Rock Island School, the others being laymen. Knapp had held a position on the original Rush faculty, and both he and Richards had recently severed their connection with the school at La Porte. The faculty of the Rock Island Medical School was given in an advertisement in the Wisconsin *Argus* (Madison), September 26, 1848, as

follows: "George W. Richards, St. Charles, Illinois, president, professor of theory and practice of medicine; M. L. Knapp, Chicago, Illinois, dean, materia medica and therapeutics; C. B. Chapman, Madison, Wis., surgery; W. S. Pierce, Rock Island, Illinois, anatomy; John F. Sanford, Farmington, Iowa, midwifery and diseases of women and children; Calvin Goudy, Taylorville, Illinois, chemistry and pharmacy; S. G. Armor, Rockford, Illinois, physiology, pathology, and medical jurisprudence; Orpheus Everts, Fond du Lac, Wisconsin, demonstrator of anatomy."

The life of the school at Davenport was short. In the spring of 1850, the college became the medical department of the State University of Iowa and was moved to Keokuk with the title of the College of Physicians and Surgeons.

The second class of the school that started in Rock Island was graduated at Keokuk in 1850. A class graduated each subsequent year, including 1899. In 1854, it became the Medical Department of the University of Iowa. In 1870, it resumed the name of College of Physicians and Surgeons. In 1899, when it graduated its last class, it merged with Keokuk Medical College to form Keokuk Medical College, College of Physicians and Surgeons. The Iowa Medical College, Keokuk, organized in 1858, was extinct in 1860. The State University of Iowa, College of Medicine, Iowa City, was organized in 1869. The first session began in 1870 and the first class was graduated in 1871; a class graduated each subsequent year. In 1912, it was absorbed by Drake University College of Medicine.

Drake University College of Medicine, Des Moines, was organized in 1881 as Iowa Eclectic Medical College, the Medical Department of Drake University. In 1883, it assumed the name of Iowa Medical College, Eclectic. In 1882, the Iowa College of Physicians and Surgeons was organized; first class graduated 1883. In 1887, this college became the Medical Department of Drake University, following the suspension of the Iowa Medical College, Eclectic. In 1903, the name changed to Drake University College of Medicine. It absorbed the Keokuk Medical College, College of Physicians and Surgeons in 1908. In 1913 it merged with the State University of Iowa College of Medicine which exists today.

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THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN these days of strenuous living filled with the daily problems of medicine, each calling for an immediate solution, it is a pleasure to stop for a few moments and recall with Compton[1] the life of Pasteur.

He is pictured with a vivid pen. The victories in science of this great benefactor of medicine and humanity and his researches, which not only have helped to solve some of the basic problems of bacteriology but also have been of great economic value to the world, have been told in an entrancing manner. Both the layman and the physician will be interested in this book. A. B. K.

THE same author, Ernest Clarke, who translated and edited Haab's *Atlas* thirty-five years ago, has sponsored a much needed volume on the fundus of the eye.[2] The plates are from the collection of Theodore Hamblin, well selected, and admirably reproduced without exaggeration of the ophthalmoscopic picture. All of the usual pathological fundi are illustrated in the fifty-one plates. The book deserves a place in the library of every ophthalmologist, and it will be useful to all others interested in ophthalmoscopy. SAMUEL A. DURR.

THE small but complete textbook on gynecology[3] by Forsdike is really an outline for students. It is clearly and simply written and profusely illustrated. The American reader will be surprised to see the Rubin patency apparatus described as "Provis' modification of Curier's model." The recommendation of the author that "the pressure may be carried to 300 millimeters mercury," seems dangerous, for it is well known that pressures above 200 millimeters mercury can produce tubal rupture. The chapter on the treatment of acute gonorrhœa includes extensive and prolonged active local treatment which is at variance with modern treatment as is the attempt to establish a clinical picture of acute endometritis. The condition known as fibrosis uteri is here described as chronic metritis. With these exceptions the volume is an excellent, usable textbook for students and should serve as an excellent introduction to the subject of gynecology. RALPH A. REIS.

IN this book[4] Livingston has compiled a "comprehensive postgraduate review" of the abdomen. He has collected material related to his subject from embryology, anatomy, physiology, chemistry, bacteriology, neurology, physical diagnosis, and surgery. The presentation of the surgical aspects is not altogether satisfying and perhaps one is captious to wonder at the inclusion of such subjects as lipoma of the thigh, femoral hernia, Raynaud's disease, technique of gastrectomy and of lumbar sympathectomy. A larger number of original illustrations would have added greatly to the book.

The section on visceral neurology is the best. The schematic studies of the viscerogenic reflexes from the gall bladder, ureter, and appendix are graphic and interesting. The discussions of the skin signs in abdominal pathology and the intraperitoneal fluids are valuable. The eponyms constitute an attractive chapter on medical history.

FREDERICK CHRISTOPHER.

THE previous editions of Dr. Wright's valuable book on *Applied Physiology*[5] have been reviewed by this journal. It is exceedingly useful to the student of medicine and surgery in that it contains considerable clinical physiology and provides a background for the comprehension and appreciation of many symptoms. It is a popular book, and justly so. Four editions have been published since 1926. This edition has been revised so that it contains many of the current advances in the field covered by the third edition. A. C. IVY.

THE textbook[6] on operative gynecology by Halban is ample proof of the fact that the technique of the Halban clinic is unsurpassed and in fact rarely equalled in the Continental clinics. A master of gynecologic operative technique himself, he presents in this volume all the standard operative procedures. He includes his own indications for each operation and makes the work even more personal by giving his own operations for high bladder fixation, genital prolapse, levator ani suture, ventrosuspension, lateral vaginal drainage, etc. In fact, each operation as set forth is the one of choice in his clinic. The text is, therefore, an accurate reflection of the operative

[1] THE GENIUS OF LOUIS PASTEUR. By Piers Compton. New York: The Macmillan Company, 1932.

[2] THE FUNDUS OF THE HUMAN EYE; AN ILLUSTRATED ATLAS FOR THE PHYSICIAN. By Ernest Clarke, C.V.O., M.D., F.R.C.S. London: Oxford University Press, 1931.

[3] TEXTBOOK OF GYNECOLOGY. By Sidney Forsdike, M.D., B.S., F.R.C.S. London: William Heinemann, 1932.

[4] A CLINICAL STUDY OF THE ABDOMINAL CAVITY AND PERITONEUM. By Edward Meakin Livingston, B.Sc., M.D. New York: Paul B. Hoeber, Inc., 1932.

[5] APPLIED PHYSIOLOGY. By Samson Wright, M.D., M.R.C.P. 4th ed. New York and London: Oxford University Press, 1931.

[6] GYNÄKOLOGISCHE OPERATIONSLEHRE. By Hofrat Prof. Dr. Josef Halban. Berlin and Vienna: Urban and Schwarzenberg, 1932.

procedures as carried out in the gynecological clinic of the Krankenhaus Wieden.

The text is written in the clear, forceful style that characterizes all of Halban's writings. The illustrations are profuse, clear, and leave nothing to be desired. This volume should rank, with Doederlein-Kroenig, as among the leading standard German works on this subject. The textbook should be owned and read by every practicing gynecologist.

RALPH A. REIS.

IN this[1] and in subsequent volumes, Meyer has attempted to record in concise and condensed form the subject matter presented in basic courses of instruction in roentgenology in the institutions with which he is connected. This brief volume discusses the abnormalities and diseases of the respiratory tract with only the necessary consideration of underlying and closely related structures. Brevity is compensated for, in part, by a complete alphabetical cross index at the end of the volume. Of the illustrations, 113 are line drawings, 68 are reproductions of roentgenograms, and 2 are photographs with descriptive matter. The author has preferred the use of numerous line drawings, showing white on a black background as simulating illustrations sketched on a blackboard during class instruction. Really for the purpose of the work the text is adequate, though for help on individual difficult cases the reader will no doubt consult current literature or more elaborate texts. The book is authoritative, practical, well arranged, and should be valuable for its purpose.

JAMES T. CASE.

SURGICAL treatment implies a knowledge of inf dications for operative procedures as well as o the technique itself; and while the latter has been adequately treated in numerous textbooks, the subject of indications has not received much attention, such information as is available being scattered throughout various texts and monographs. Reschke, therefore, felt that there was an urgent need for work dealing specifically with the question of indications.

The present work[1] is intended primarily for the practitioner and student who are naturally more concerned with the question of what to do rather than with how to do. The discussion of debatable subjects, moreover, should make it valuable reading for the younger surgical assistants. The first volume is devoted to the consideration of general topics: examination of cardiovascular system, of heart and of metabolism, local anæsthesia, general anæsthesia, injuries, healing, acute and chronic infections, chronic diseases of joints, rickets, circulatory diseases, amputations, and tumors. The chapters mentioned are well written and, because of their brevity, will not overwhelm the beginner with detail. A valuable feature is an appended bibliography at the end of the volume, which, while far from being exhaustive, could at least serve as a starting point for further reading.

GEO. HALPERIN.

FIFTH in the series of monographs on pathological problems of clinical interest is Professor Dietrich's treatise on thrombosis.[3] For more than 20 years studies of the author have added valuable knowledge to the problems of thrombosis. The present volume is not intended as a simple summary of the literature. Although the bibliography is quite complete, the author naturally stresses his own findings, which have gradually developed into a general conception of the pathogenesis of thrombosis.

Thrombosis is not a simple intravascular coagulation of the blood. Therefore studies on coagulation-time, of leucocytes, blood platelets, cannot indicate imminent thromboses. The sedimentation test and the changes in blood colloids may give some insight into important changes of the plasma, but they are still not decisive factors.

The slowing down or standstill of the circulation is a favoring factor and their importance can be demonstrated in the structure of the thrombus itself. But circulatory disturbances alone will not explain thrombosis as blood may remain fluid between two ligatures.

Injuries to the endothelium, preferably combined with a slowing down of circulation, lead to localized thrombosis, but do not explain progressive thrombosis. Besides in spontaneous thromboses gross changes in the intima are often absent.

The decisive factor, according to the author's animal experiments, are the correlations between the blood and endothelium, which can be augmented to an increased reactivity of the intima to protein destruction. Precipitations, cellular reactions of the intima can occur, which, if favored by circulatory disturbances and changes in the plasma, will lead to thrombosis.

Infection may favor thrombosis in several ways. Bacteria may be arrested at points of increased reactivity and produce cellular exudates followed by thrombosis. This must occur in multiple, simultaneous thrombi, that are found on valves. Or infection may produce a general sensitization of the endothelium, which will form clots if the circulation slows down. Thus from the aseptic bland thrombosis through the thrombosis with marked inflammatory reaction to suppurative phlebitis there is a gradual difference of endothelial reactivity indicating success or complete breakdown of a defensive reaction.

Thrombosis then is a general disease; while a localized thrombus may be a favorable reaction, the progressive, repeated thrombosis, which organizes in places and reforms elsewhere, may produce sudden, massive, poorly adherent clots, which are most dangerous from the standpoint of embolism.

Pulmonary embolism occurred in 53 per cent of thromboses in the author's large postmortem mate-

[1] CLINICAL ROENTGEN PATHOLOGY OF THORACIC LESIONS. By William H. Meyer, M.D. Philadelphia: Lea & Febiger, 1932.

[2] CHIRURGISCHE INDIKATIONEN FÜR ÄRTZE UND STUDIERENDE. Part 1 By Prof. Dr. Karl Reschke. Berlin: F. C. W. Vogel, 1932.

[3] PATHOLOGIE UND KLINIK IN EINZELDARSTELLUNGEN. Vol. iv THROMBOSE, IHRE GRUNDLAGEN UND IHRE BEDEUTUNG. By Professor Dr. A. Dietrich. Berlin and Vienna: Julius Springer, 1932

rial. In 35.3 per cent it was fatal. Death occurs if more than two-thirds of the pulmonary circulation is obstructed. Diseased lungs will naturally stand less injury. Only about half of the cases of pulmonary embolism have typical clinical symptoms. Paradox embolism from veins into peripheral arteries is not uncommon through an open foramen ovale.

These are some of the most important statements which have practical significance. No progressive surgeon can ignore this stimulating monograph and its intriguing hypothesis which is backed up by a considerable amount of experimental evidence.

GEZA DE TAKATS.

UNDER the title of *Surgical Errors and Safeguards*,[1] Dr. Thorek has given us, in a most refreshing and original style, his viewpoint on a wide range of surgical conditions. It represents the knowledge and experience gained in twenty-five years of surgery, and "from constant scientific intercourse with some of the world's greatest contemporary surgeons." The operations are taken up regionally, and an effort is made to point out what *not* to do under various circumstances. The book contains a great deal of valuable surgical information.

No book can suit everyone, but the following statements particularly are ones with which surgeons might take issue: "Spinal anesthesia in the hands of a well trained surgeon, is a safe method" (p. 24). In the discussion of gastric resections the younger surgeon may be somewhat disquieted by "Do not be guided by the statistics of anyone! Let your own experience be your guide" (p. 231). And despite the recent work of A. H. Montgomery, "Short-circuiting operations in intestinal intussusception should not be done. They are dangerous procedures, often followed by failure and death" (p. 299). Legend of Figure 340, p. 367, "Carcinoma of the gall-bladder caused by irritation from biliary calculi." It cannot be too strongly stressed that the uterine vessels should not be ligated unless the ureter is clearly seen to be free" (discussion of hysterectomy p. 552).

But sixteen pages are devoted to fractures and twelve pages to the "Errors and Safeguards in Surgery of the Spine and Spinal Cord." No mention was found of the Levin tube in the treatment of postoperative vomiting, nor of the Gallie, fascial suture, methods of treating hernias. The illustrations are numerous and for the most part very good.

FREDERICK CHRISTOPHER.

THE monograph[2] on intracranial tumors by Harvey Cushing is more than a statistical enumeration of the mortality percentages of the author's operations upon intracranial tumors. Within its pages are concealed the brilliant results and the anguish of Dr. Cushing's thirty years of devotion to the field of neurological surgery. Its pages tell the story of the large group of younger men who have been taught by him and have been stimulated by his unswerving course toward the goal of advancing this comparatively young branch of surgical endeavor.

Quite unlike most statistical studies, this book provides interesting reading even to those whose interests are neither primarily surgical nor neurological. Elsewhere, the author has considered the technical and diagnostic matters relating to intracranial tumors of a particular type or in a given situation. Here he has given definite information about the surgical results which have been attained by the various procedures employed. The data which has been compiled, the experimental and investigative, by paths which have been opened by the careful study of these two thousand cases which have been verified by microscopic section, to say nothing of the general mortality percentage achieved, leave a mark for other neurological surgeons to equal or better.

To leave a record of carefully controlled results should be the aim of every surgeon. To have written that record with such a charming, interesting, and typically characteristic literary style adds still another score for a younger generation to emulate.

THE interval, 35 years, between the first publication of Muir's *Manual of Bacteriology*[3] and the last covers a very considerable part of the history of the science of bacteriology. Even in the preface to the first edition the authors remarked that the science of bacteriology had become so extensive that it was necessary to restrict its treatment to some special departments. The extent of the development of the science, comprehended by their subsequent editions, undoubtedly has been far greater than any prediction they might have then made. Few current textbooks have witnessed the growth of so large a proportion of their subjects. The publication of a ninth edition is indicative of the sustained worth and popularity of the book. The general character, form, and purpose, a book primarily for students and practitioners of medicine, is unchanged. Consequently, it confines itself to the bacteria associated with disease in man and chapters on protozoal diseases and pathogenic fungi. To meet the changes and additions which have taken place during the 5 years since the previous edition, some out-of-date material has been eliminated and extensive revisions made. This has been accomplished with little enlargement of the volume although the use of much small type has resulted. It may be objected that, in the endeavor to be concise, certain subjects have not been given sufficient discussion, as for example bacterial dissociation and specific soluble substances. However, in criticizing textbooks it should be recog-

[1] SURGICAL ERRORS AND SAFEGUARDS. By Max Thorek, M.D. With a foreword by Arthur Dean Bevan, M.D. Philadelphia, Montreal, and London: J. B. Lippincott Company, 1932.

[2] INTRACRANIAL TUMORS; NOTES UPON A SERIES OF TWO THOUSAND VERIFIED CASES WITH SURGICAL-MORTALITY PERCENTAGES PERTAINING THERETO. By Harvey Cushing. Springfield, Illinois, and Baltimore, Maryland: Charles C Thomas, 1932.

[3] MANUAL OF BACTERIOLOGY. 9th ed. By Robert Muir, M.A., M.D., Sc.D., LL.D., F.R.S., and The Late James Ritchie, M.A., M.D., F.R.C.P. (Ed.). Revised by Carl H. Browning, M.D., D.P.H., F.R.S., and Thomas J. Mackie, M.D., D.P.H. New York and London: Oxford University Press, 1932.

nized that there is little agreement as to how they should be constructed and the relative values which should be assigned to their contents. While this book is more widely used in England than in the United States, nevertheless it is so well known here that an extended review is unnecessary. In appraisement it may be stated that the previous high level of merit is maintained. A. A. DAY.

THE importance of familiarizing the public with certain phases of the cancer problem has been fully recognized by the medical profession. The education of the laity in cancer control presents peculiar difficulties and is a task of great delicacy. Dr. Tobey has succeeded in overcoming most of these difficulties. Although his book[1] is addressed primarily to the layman, the physician will find in its pages much of interest and instruction.

The chapter on famous persons who have suffered from cancer is of unusual historical interest and refers to emperors, kings, and presidents, who have been victims of this disease. The chapters describing the nature of cancer, and its signs, symptoms, and treatment, are authentic and clearly written. The chapters on false cancer cures and cancer quackery should do much to help warn the laity of these dangerous public enemies.

Upon the question of whether the patient should be told that he is suffering from cancer, the author will encounter differences of opinion. Many eminent authorities consider that the use of the term cancer before a cancer patient is a psychological error. With this view the reviewer is in complete accord. In this connection the use of the word "tumor" has innumerable psychological advantages, but as Dr. Tobey emphasizes, each patient presents an individual problem and must be treated accordingly.

The statements contained in the book are entirely reliable and represent an authoritative opinion on the subject of cancer. In a simple, clear, and attractive style the author has presented a difficult medical subject to the layman. He has told his story in a most interesting fashion. Dr. Tobey's comprehensive treatise contains important information for the layman and is a valuable contribution to the problem of cancer control. The author is to be congratulated upon the clear, accurate, and attractive presentation of his difficult subject. MAX CUTLER.

THE textbook,[2] on psychiatry by Henderson and Gillespie, first published in 1927, is now in the third edition. As in previous editions psychiatry is here represented as a dynamic, living, and growing body of knowledge and its relations to general medicine are described, as are its social and legal implications. The first part contains material on the history of psychiatry, the classification and etiology of mental diseases, methods of examination, symptomatology, and general psychopathology. Then the individual diseases are described and each psychiatric proposition is illustrated by the citation of cases. In this edition there is a chapter on the most recent development in psychiatry, the psychiatry of childhood. The part which deals with the complex relation of psychiatry and the law is useful and practical. There is a bibliography of the most important psychiatric source materials. There is noted throughout a strict tendency to separate fact from conjecture, a circumstance worthy of more than passing notice in a present day psychiatric work. This text is sufficiently conservative to be safely recommended to the beginner; it contains sufficient information to be of value to the advanced student.

HARRY A. PASKIND.

[1] CANCER: WHAT EVERYONE SHOULD KNOW ABOUT IT. By James A Tobey, Dr P.H. With introduction by Joseph Colt Bloodgood, M.D. and H. L. Mencken. New York: Alfred A. Knopf, 1932.

[2] A TEXTBOOK OF PSYCHIATRY; FOR STUDENTS AND PRACTITIONERS. 3d ed. By D. K. Henderson, M.D. (Edin.), F.R.F.P.S.(Glas.), and R. D. Gillespie, M.D.(Glas.), M.R.C.P., D.P.M.(Lond.). New York and London: Oxford University Press, 1932.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

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CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

ALLEN B. KANAVEL, Chicago, *President* J. BENTLEY SQUIER, New York, *President-Elect*
FRANKLIN H. MARTIN, Chicago, *Director-General*
EVARTS A. GRAHAM, St. Louis, *Chairman, Committee on Arrangements*

PLANS FOR THE 22D ANNUAL CLINICAL CONGRESS IN ST. LOUIS

THE surgeons of St. Louis are keenly interested to provide for the Fellows of the American College of Surgeons and their guests at the twenty-second annual Clinical Congress to be held in St. Louis October 17–21, a complete showing of the surgical activities of their city with its two splendid medical schools and many fine large hospitals. The Committee on Arrangements, comprised of representatives of all of the medical institutions of that city, is preparing a program of operative clinics and demonstrations in all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, proctology and surgery of the eye, ear, nose, throat and mouth. Clinics are scheduled for the afternoon of Monday, October 17, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days.

Clinics and demonstrations will be given at the medical schools of Washington University and St. Louis University; Central Institute for the Deaf, Mallinckrodt Radiological Institute, Oscar Johnson Institute; and at the following hospitals: Alexian Brothers, Barnard Free Skin and Cancer, Barnes, Bethesda, Christian, DePaul, Evangelical Deaconess, Firmin des Loges, Frisco Employes', Jewish, Lutheran, McMillan, Missouri Baptist, Missouri Pacific, Mount St. Rose, St. Anthony's, St. John's, St. Louis Children's, St. Louis City, St. Louis County, St. Louis Maternity, St. Luke's, St. Mary's, St. Mary's Infirmary, Shriners', United States Marine, Veterans No. 92.

The program, originally published in the June issue of SURGERY, GYNECOLOGY AND OBSTETRICS and in the *Bulletin* of the College for June, is to be republished in revised form in the September issue. During the months preceding the Congress the hospital schedules will be further revised and amplified under the direction of the Committee on Arrangements, so that in its final form the program will present a completely detailed schedule of the clinical work to be demonstrated.

COMMITTEE ON ARRANGEMENTS

Evarts A. Graham, Chairman
F. A. Jostes, Secretary

Executive Committee

Fred Bailey	Roland Hill
M. B. Clopton	F. A. Jostes
William T. Coughlin	W. C. G. Kirchner
L. W. Dean	H. G. Mudd
Ellis Fischel	Max Myer
Evarts A. Graham	

Willard Bartlett	McKim Marriott
Clarence H. Crego, Jr.	Harvey S. McKay
W. C. Gibson	James Mudd
William P. Glennon	Louis Rassieur
Max Goldstein	Francis Reder
John Green	William E. Sauer
H. A. Hanser	Otto Schwarz
Harvey J. Howard	Alphonse M. Schwitalla
Charles E. Hyndman	Major Seelig
Walter Jones	Omar R. Sevin
R. Emmet Kane	Carroll Smith
W. E. Leighton	Max Starkloff
Curtis H. Lohr	Ross Woolsey
William H. Luedde	O. B. Zeinert

Sub-Committees

Ophthalmology and Otolaryngology—L. W. Dean, Chairman; Max Goldstein, John Green, Harvey J. Howard, William H. Luedde, William E. Sauer.

Community Health Meeting—Ellis Fischel, Chairman; Fred Bailey, Charles E. Hyndman, F. A. Jostes, Francis Reder.

Publicity—Major Seelig, Chairman.

Modern methods in the treatment of fractures will be demonstrated as a feature of the clinical program, and at several of the hospitals plans are being made for a comprehensive showing of the methods used and the results obtained in the treatment of fractures which forms so large a part of surgical work in large cities and industrial centers. Other important features of the clinical program include demonstrations of the treatment of cancer by surgery, radium and X-ray; the rehabilitation by surgery and physiotherapy of patients injured in industrial and automobile accidents, etc.

The annual meeting of the American College of Surgeons will be held in the ballroom of the Jefferson Hotel on Thursday afternoon beginning at 1:30 for the reception of reports by officers and committees, and the election of officers, regents and governors.

Among the distinguished visitors from abroad who will attend the Clinical Congress is Dr. José Goyanes, Professor of Surgery in the National Academy of Medicine of Madrid, Spain; and President of the Society of Surgeons of Madrid.

SPECIAL FEATURES

A conference under the auspices of the Board on Traumatic Surgery and Industrial Medicine of the College is being arranged for Friday afternoon in the ballroom of the Jefferson Hotel that will include a discussion of the various phases of this important activity of the College, together with a report outlining its present and future activities in respect to a nation-wide survey of the medical and surgical facilities of our industries.

A symposium on fractures on Wednesday afternoon will be presented in co-operation with the Fracture Committee of the College under the Chairmanship of Dr. Charles L. Scudder of Boston. This symposium will deal with methods of diagnosis and treatment of fractures of individual bones—practical presentations by surgeons of wide experience.

A daily exhibition of surgical films in the ballroom of the Statler Hotel is being planned. A large number of new surgical films, both sound and silent, will be shown.

EVENING MEETINGS

An outline of the program for a series of evening meetings will be found in the following pages. At the presidential meeting on Monday evening in the ballroom of the Jefferson Hotel, the president-elect, Dr. J. Bentley Squier, of New York, will be inaugurated and deliver the annual address. On the same evening the John B. Murphy oration in surgery will be delivered by Sir William I. DeCourcy Wheeler, of Dublin, Ireland.

At scientific sessions on Tuesday, Wednesday and Thursday evenings in the ballroom of the Jefferson Hotel a number of papers on various phases of surgery will be presented by eminent surgeons of the United States, Canada and England.

The annual Convocation of the College will be held on Friday evening in the ballroom of the Jefferson Hotel at which the 1932 class of candidates for Fellowship in the College will be received. The Fellowship address will be delivered by Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology.

Two meetings of special interest to ophthalmologists and otolaryngologists will be held on Tuesday and Thursday evenings in the ballroom of the Statler Hotel with addresses by eminent specialists.

TEACHING OF SURGERY AND THE SURGICAL SPECIALTIES

A committee appointed by the American College of Surgeons is assembling information on the teaching of surgery and the surgical specialties, to be presented at a meeting at two o'clock Wednesday afternoon, October 19, in the Jefferson Hotel. Dr. Fred C. Zapffe of Chicago is secretary of the Committee.

The opinions of chiefs or heads of surgical departments in the undergraduate, graduate, and postgraduate medical schools of the United States and Canada are being solicited. The purpose in view is to present for consideration an outline of approved courses in surgery and the specialties, such outline to be used in building courses in individual schools to meet local demands, needs, and facilities, both as to personnel and equipment.

No attempt will be made to standardize the teaching of surgery or of the specialties. The report will comprise the opinions of teachers of these subjects; it will emphasize what they believe to be the best means of imparting fundamental principles, and of laying a sound foundation for future development; and it will stress the best and most effective undergraduate, graduate, and postgraduate training of the surgeon and specialist of the future, based on the consensus of opinion of teachers in these important fields.

HOSPITAL STANDARDIZATION CONFERENCE

For the fifteenth annual Hospital Standardization Conference of the American College of Surgeons beginning on Monday, October 17, and continuing through Thursday, a highly instructive program of practical value is being prepared consisting of addresses, papers, round table conferences and demonstrations. The entire program is being built around the problems affecting the hospital field at the present time. An opportunity will be given for extemporaneous discussion of problems other than those indicated on the program. Speakers of note from both the United States and Canada will lead the discussions.

There will be two evening sessions—Tuesday evening for hospital trustees, and Wednesday evening for social service workers. These sessions

SYMPOSIUM: CANCER IS CURABLE

Thursday, 2:30 P.M.—Ballroom, Jefferson Hotel

CANCER is curable. It is in the incipient stage of cancer that proper treatment produces the greatest number of cures. Incurable cancers are almost invariably the result of failure of early recognition of the disease. Wise propaganda will disseminate to the public facts about cancer that should be within the knowledge of every man and woman. It will impress upon the public and the practitioners of medicine—the family doctors—the importance of early and periodic advice, based on accurate diagnosis. And nothing will lend greater encouragement to the public than assurance that *cancer is curable.*

Based on these indisputable facts, the College will present a clinical symposium on the afternoon of Thursday, October 20, that will emphasize the curability of cancer. Each of twenty clinicians will present a summary of five-year cancer cures recorded in his practice. Through the Committee on the Treatment of Malignant Diseases, Dr. Robert B. Greenough, Chairman, the College is in a position to report many five-year cancer cures. But thousands of such cases are unrecorded, and it will be advantageous to the profession, and revolutionize the attitude of the public toward the entire subject, if the College, a thoroughly disinterested body, will record additional cases in the medical literature as proof of the curability of cancer. These brief, definite summaries will be published in the issue of the official journal of the College and the Congress — SURGERY, GYNECOLOGY AND OBSTETRICS—which is devoted to the transactions of the Congress.

SYMPOSIUM: CANCER CLINICS

Thursday, 9:30 A.M.—Ballroom, Jefferson Hotel

WHOLESOME dissemination of information on the curability of cancer will impel the educated man and woman to demand facilities for early diagnosis. After careful consideration of all phases of the subject, the American College of Surgeons has taken the stand that the best means immediately available to improve the care of cancer cases, and to reduce the excessive cancer mortality, is through the organization of cancer diagnostician clinics in already existing hospitals and other approved institutional clinics where cancer can be specially treated.

The symposium on cancer clinics will be participated in by men selected on account of their activities in institutions of different types. Concrete examples of organization for the care of cancer in different types of institutions will be presented, and some of the specific problems that are common to all cancer clinics will be discussed.

will be of interest not only to the respective groups indicated but of general interest to all hospital people.

The conference will conclude with a series of demonstrations of departmental services on Thursday in two St. Louis hospitals, which will show the newest developments in departmental equipment, organization, and management. As a complement to the program there will be an educational exhibit of organization charts, personnel ratio schedules, hospital plans, etc.

A special effort is being made to interest members of governing bodies of hospitals, medical staffs, and department heads, in addition to hospital executives, in this program. In addition to the program at headquarters there are many things of interest to be seen in the St. Louis hospitals in the way of the newest ideas in construction and equipment.

COMMUNITY HEALTH MEETING

A unique feature of this year's Clinical Congress will be a community health meeting to be held on Wednesday evening, in the gymnasium of the St. Louis University, to which the public will be invited. A number of speakers of renown at-

tending the Clinical Congress will deliver brief, interesting, instructive talks on health and hospitals, illustrated, in most part, by lantern slides and motion pictures. In this way the College offers to the citizens of St. Louis and vicinity an opportunity to participate in its program of health education.

HEADQUARTERS

General headquarters for the Clinical Congress will be established at the Jefferson Hotel, 12th and Locust streets, where the ballroom, Crystal and Ivory rooms and foyers adjacent thereto on the mezzanine and second floors have been reserved for the exclusive use of the Congress for scientific meetings, conferences, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc. The ballroom of the Statler Hotel, at Washington and 9th streets, will be utilized daily for film exhibitions and certain scientific sessions.

TECHNICAL EXHIBITION

An interesting feature at headquarters will be the Technical Exhibition for which space has been reserved on the mezzanine floor including the Crystal and Ivory rooms and large foyers adjacent thereto. There will be represented in this exhibition the leading manufacturers of surgical instruments, X-ray apparatus, operating room lights, hospital apparatus of all kinds, ligatures, bandages, pharmaceuticals; publishers of medical books, etc.

ADVANCE REGISTRATION

Attendance at the St. Louis session will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. It will be necessary, therefore, for those who wish to attend the Clinical Congress in St. Louis to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of $5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

ST. LOUIS HOTELS AND THEIR RATES

	Minimum rates with bath	
	Single	Double
American, Market and Seventh Sts....	$1.50	$2.50
American Annex, Market and Sixth Sts.	1.50	2.50
Chase, Lindell Blvd. at Forest Park....	3.00	5.00
Claridge, Locust and Eighteenth Sts...	2.00	3.00
Congress, Union Blvd. and Pershing Ave.	3.00	4.00
Coronado, Lindell Blvd. and Spring Ave.	3.00	4.50
Fairmont, Maryland and Euclid Aves..	2.50	3.50
Forest Park, W. Pine Blvd. and Euclid	2.50	4.00
Gatesworth, Union and Lindell Blvds..	3.00	4.50
Jefferson, Twelfth Blvd. and Locust St.	3.00	4.00
Kings-Way, Kingshighway and W. Pine	2.00	3.00
Robert E. Lee, Eighteenth and Pine Sts.	....	3.50
Lennox, Ninth and Washington Ave...	3.50	5.00
Majestic, Eleventh and Pine Sts.....	2.00	3.00
Mark Twain, Eighth and Pine Sts.....	2.50	4.00
Marquette, Eighteenth and Washington	2.00	3.00
Maryland, Ninth and Pine Sts.....	2.00	3.00
Mayfair, Eighth and St. Charles Sts...	3.50	5.00
Melbourne, Grand Ave. and Lindell	2.50	4.00
Missouri, Locust and Eleventh Sts.....	2.00	3.00
Park Plaza, Kingshighway at Maryland.	4.00	5.00
Roosevelt, Delmar and Euclid Ave....	2.50	4.00
Senate, Union Blvd. and Pershing Ave.	3.00	4.00
Statler, Ninth and Washington Sts.....	4.00	6.00
Warwick, Fifteenth and Locust Sts....	2.50	4.00

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the St. Louis session of the Clinical Congress so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to St. Louis, procuring from the ticket agent when purchasing ticket, a "convention certificate," which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of a viséd certificate to the ticket agent in St. Louis not later than October 25, a ticket for the return journey by the same route as traveled to St. Louis may be purchased at one-half the one-way fare.

In the eastern, central, and southern states and eastern provinces of Canada tickets may be purchased between October 14 and 20; in other sections of the United States and Canada at

(*Continued on page 264*)

PRELIMINARY PROGRAM FOR EVENING MEETINGS

BALLROOM, JEFFERSON HOTEL

Presidential Meeting—Monday Evening

Invocation.

Address of Welcome: EVARTS A. GRAHAM, M.D., St. Louis, Chairman, Committee on Arrangements.

Introduction of Foreign Guests.

Address of Retiring President: Intangibles in Surgery. ALLEN B. KANAVEL, M.D., Chicago.

Inaugural Address: J. BENTLEY SQUIER, M.D., New York.

The John B. Murphy Oration in Surgery: Pillars of Surgery. SIR WILLIAM I. DE COURCY WHEELER, M.S., F.R.C.S.I., Dublin, Ireland.

Tuesday, Wednesday, and Thursday Evenings

Symposium on Surgery of the Large Bowel:

Diverticulitis of the Large Bowel. VERNON C. DAVID, M.D., Chicago.

The Hopeful Prognosis of Carcinoma of the Colon. FRED W. RANKIN, M.D., Rochester, Minn.

Gynecological Symposium:

The Results of Irradiation in the Treatment of Functional Uterine Bleeding Based upon a Study of Four Hundred Cases. FLOYD E. KEENE, M.D., Philadelphia.

The Detection of Clinically Latent Cancer of the Cervix. WILLIAM P. GRAVES, M.D., Boston.

Fracture Oration: Fractures about the Elbow. PHILIP D. WILSON, M.D., Boston.

Oration: Industrial Medicine and Traumatic Surgery. FREDERIC A. BESLEY, M.D., Waukegan, Ill.

Inflammation. SIR GEORGE LENTHAL CHEATLE, K.C.B., C.V.O., F.R.C.S., London, England.

Bronchiectasis and Its Treatment by Lobectomy in One Stage. HAROLD BRUNN, M.D., San Francisco.

A Discussion of Some Principles Involved in the Pathology and Treatment of Empyema Thoracis. JOSEPH A. DANNA, M.D., New Orleans.

An Experimental and Clinical Study of the Use of Radium in the Brain. LOYAL DAVIS, M.D., and MAX CUTLER, M.D., Chicago.

Some Observations on Appendicitis: A Review of Four Thousand Appendectomies. J. M. T. FINNEY, JR., M.D., Baltimore.

Convocation—Friday Evening

Invocation.

Conferring of Fellowships.

Conferring of Honorary Fellowships.

Presidential Address. J. BENTLEY SQUIER, M.D., New York.

Fellowship Address: Some New Things in Physics. ROBERT ANDREWS MILLIKAN, Ph.D., LL.D., Sc.D., Nobel Laureate; Director, Norman Bridge Laboratory of Physics. and Chairman of the Executive Committee, California Institute of Technology, Pasadena.

SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

Ballroom, Statler Hotel—Tuesday and Thursday Evenings

Highways and Byways in Ophthalmology. HANS BARKAN, M.D., San Francisco.

History and Development of the Operative Treatment of Facial Palsy. ARTHUR B. DUEL, M.D., New York.

Suppuration of the Petrous Apex in Relationship to Meningitis. WELLS P. EAGLETON, M.D., Newark, N. J.

earlier dates. The return journey must be completed within thirty days from date of sale of ticket to St. Louis.

The reduction in fares does not apply to Pullman fares nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to St. Louis, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and viséd by a special railroad agent at Clinical Congress headquarters on or before October 21. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used in going to St. Louis and that the certificate must be deposited at headquarters during the meeting and return ticket purchased not later than October 25.

An exception to the above arrangement is to be noted in the case of persons traveling from points in certain far western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including October 15 with a final return limit of October 31. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to St. Louis by way of a direct route and returning by way of another direct route with liberal stop-over privileges.